Knowledge Transfer
2017

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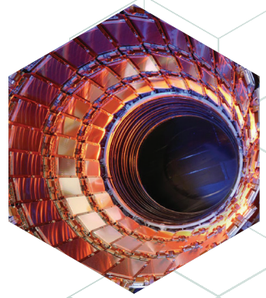



“HISTORY SHOWS THAT MAJOR BREAKTHROUGHS, WHICH TRANSFORM SOCIETY AND OUR LIVES IN RADICAL WAYS, OFTEN COME FROM FUNDAMENTAL RESEARCH.” *FABIOLA GIANOTTI, CERN DIRECTOR-GENERAL.*

A word from Fabiola Gianotti, CERN Director-General

CERN’s mission is the pursuit of knowledge through curiosity-driven research. The Laboratory was created to explore the fundamental particles and their interactions, with the goal of helping us to understand how the universe works. CERN’s founding fathers were well aware that to achieve the very ambitious scientific objectives of the Organization, cutting-edge instruments would have to be developed. For more than 60 years, the work of thousands of scientists from all over the world has pushed back the limits of knowledge in fundamental physics, as well as in many fields of technology. It is part of CERN’s mission to ensure that our innovations bring practical benefits to society as a whole.

We use a variety of avenues to bring CERN innovation to society, ranging from education, communication and outreach to formal Knowledge Transfer (KT) activities. We have a CERN KT fund to stimulate innovation. It has funded 41 projects since 2011, while our Medical Applications budget has funded 25 projects since 2014. We promote entrepreneurship and we grant licences for companies to develop our technologies. All this is done to ensure a strong return on investment for policy makers, industry, and the general public.

Key examples from 2017 include the first radioisotopes produced by the CERN-MEDICIS facility for cancer treatment research. This facility puts over 50 years of CERN expertise at the disposal of the medical community. An agreement signed in June with France’s space agency, CNES, brings CERN expertise in radiation resistance of materials and electronics to the space industry. In collaboration with the Italian institute for nuclear physics, INFN, we started R&D into the next generation of accelerators for cultural heritage, a timely development since 2018 is the European Year of Cultural Heritage. Finally, it is worth noting that 23 start-ups are now using CERN technology, some hosted in the nine Member State Business Incubation Centres (BICs).

These are just a few examples. You can explore them and others in the pages of this report. I wish you enjoyable reading, and I encourage you to participate in CERN’s knowledge transfer activities, helping to ensure that CERN know-how is put to the best possible use in society.

A word from Thierry Lagrange, Head of the Industry, Procurement & Knowledge Transfer Department and Giovanni Anelli, Knowledge Transfer Group Leader

CERN inspires visionary thinking. Since its beginnings, it has acted as a trailblazer in the technologies related to accelerators, detectors and computing. As a laboratory with a long-term research plan, it is continuously innovating. Whether in robotics or sensors, in superconductivity or in digital sciences like machine learning: CERN technologies can bring concrete business solutions that benefit our Member State industries and society.

2017 marked twenty years since CERN set up a reinforced policy and team to support its knowledge and technology transfer. Today these activities are stronger than ever, and have led to hundreds of collaboration agreements from the field of medtech and aerospace, and from industry 4.0 to cultural heritage. The diversity of the application domains of CERN technologies is enlightening. This year, we are particularly thrilled to showcase several success stories related to cultural heritage, a field which may seem far removed from high-energy physics, and yet has natural links with CERN’s expertise in digital preservation and imaging techniques.

This report aims to showcase the impressive breadth of CERN’s impact and its return for our Member States, which happens by creating value through technological, economic, societal, cultural and human capital. Our Knowledge Transfer (KT) Forum, held several times per year, brings together CERN’s KT group and KT representatives from each Member State. It is part of our strategy to ensure a strong return for Member States. This year we also held a special KT Forum dedicated to medical applications, as part of the implementation of our new CERN Medical Applications Strategy approved in 2017.

The goal of the Knowledge Transfer group, which is part of the Industry, Procurement and Knowledge Transfer (IPT) department, is to maximise the positive impact of CERN technologies on society. Industry is a key player in this equation, and the IPT department is the first point of contact for industry at CERN.

Looking towards the future, in 2018, the KT group aims to increase its collaborations with multinational companies, and create opportunities where they can benefit from CERN’s unique experience in problem-solving and technological innovation. We want to focus more on the challenges faced by industry today, and look at how our technologies and know-how can provide solutions. In addition, we aim to continue to develop the culture of entrepreneurship at CERN. With our Entrepreneurship Meet-Ups and Business Incubation Centres, we hope to grow the number of start-ups using CERN technologies.

CERN KNOWLEDGE TRANSFER AT A GLANCE

FROM CERN TO SOCIETY VIA INDUSTRY

18
Technology domains of CERN expertise

6
Application fields showcased in 2017, from medtech to aerospace, and from industry 4.0 to cultural heritage

ENTREPRENEURSHIP

23
Start-ups & spin-offs using CERN technology

9
Member State Business Incubation Centres

CERN KNOWLEDGE TRANSFER FUND

41
Projects funded since 2011

15-220 kCHF
Range of funding received per project

CERN MEDICAL APPLICATIONS BUDGET

25
Projects funded since 2014

64 kCHF
Average funding received per project

EUROPEAN COMMISSION CO-FUNDED PROJECTS

5
Current CERN EC co-funded projects with a strong KT component

>63 M Euros
Total project costs

INTERNATIONAL ORGANISATIONS

15
Bilateral cooperation agreements with scientific and international organisations

5
Sustainable development goals (SDGs) in which CERN fully contributes within its current mandate

KEY FIGURES FOR 2017

INTELLECTUAL PROPERTY AND LICENSING

73
New technologies disclosed internally

41
Knowledge Transfer contracts signed

EVENTS

21
Countries where KT-related events were held

950
People attended the CERN Knowledge Transfer Seminars in person or via webcast

HUMAN EXCELLENCE AND EDUCATION

2416
Active Alumni members as of December 2017

>2 Million
Mentions of CERN or the LHC on social media

952
High-school teachers in CERN's 2017 Teacher programmes

FROM CERN KNOWLEDGE TO SOCIETY

KNOWLEDGE TRANSFER AT CERN

Operating with a budget comparable to a medium-sized European university, CERN is one of the world's leading centres for particle physics, and produces cutting-edge science and technology. The unique know-how and expertise of CERN scientists and engineers provides excellent opportunities to bridge the gap between science and society. This happens in many ways, one of which is by harnessing technological advances to create concrete solutions for industry in many fields from medical and biomedical technologies to aerospace applications, and from industry 4.0 to cultural heritage.

FROM CERN TO SOCIETY VIA INDUSTRY

The core mission of CERN is fundamental research in particle physics. Yet, as a publicly funded laboratory, it also has a remit to ensure that its technology and expertise deliver prompt and tangible benefits to society wherever possible. A myriad of engineers, technicians and scientists develop novel technology and know-how that can be applied to other fields than high-energy physics, by transferring them to industry for the benefit of society. This is made possible by the CERN community, which represents the human capital that develops the expertise and shares it with society. This also happens through CERN staying in close contact with innovation actors from industry – including large companies, SMEs or recent start-ups. CERN engages with other stakeholders, such as policy makers, especially those acting in CERN's Member States.

20 YEARS OF A REINFORCED KNOWLEDGE TRANSFER STRUCTURE AT CERN

Since its creation in 1954, CERN has been active in transferring technology to industry, mainly through procurement contracts or collaboration agreements. As its impact broadened, in 1997 CERN set up a reinforced policy and team to support its knowledge and technology transfer activities, with the backing of the CERN Council. Twenty years later, these activities are still going strong. 23 start-up companies around the world are currently using CERN technology, and CERN has developed a network of Business Incubation Centres (BICs) in nine different Member States. In 2017, CERN signed 41 agreements with external partners and industry.

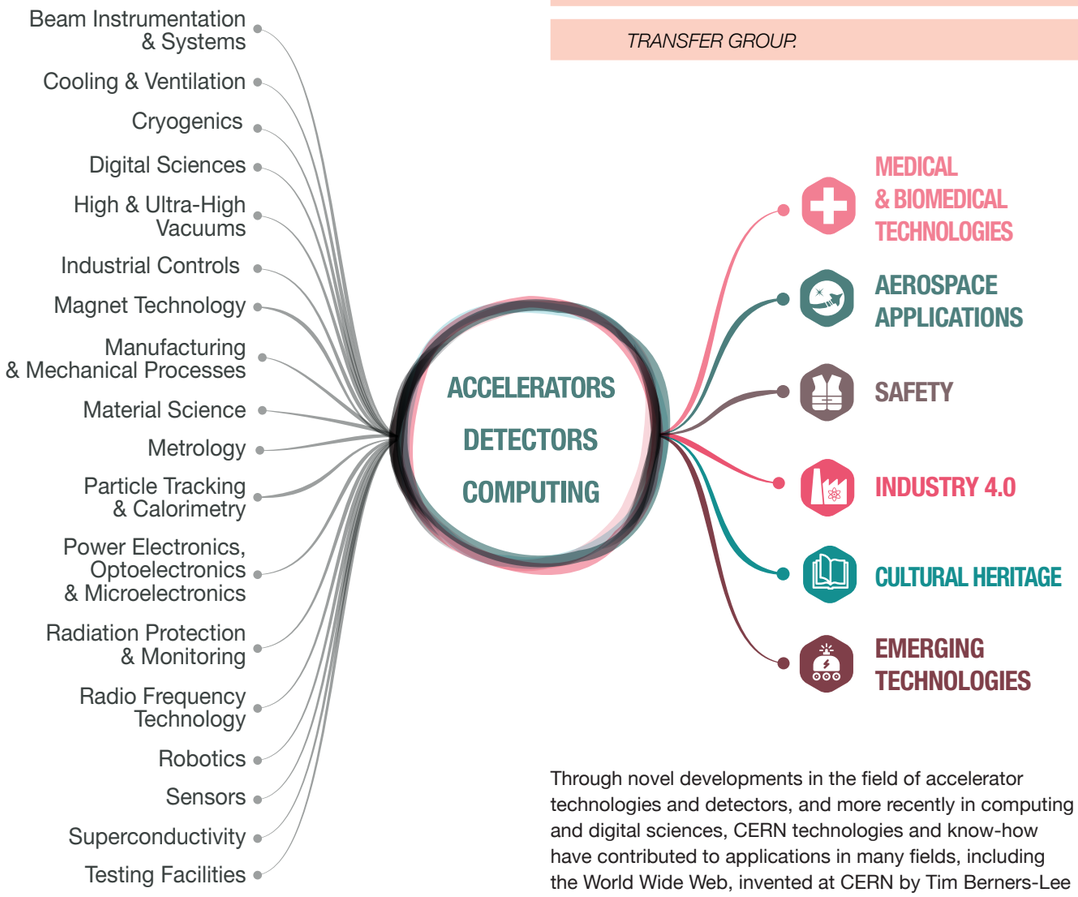
RETURN FOR MEMBER AND ASSOCIATE MEMBER STATES

CERN is governed by its 22 Member States, and its success is in large part due to this broad international support. To accelerate industry links and create new opportunities for its Member States, CERN actively engages with them. This happens through its dedicated Knowledge Transfer Forum, and through national industry days, like Italy@CERN, Germany@CERN, Norway@CERN and UK@CERN in 2017. Through its entrepreneurship activities, CERN encourages the use of CERN technology in start-ups, and fosters the creation of Member State Business Incubation Centres (BICs). This return comes at a low cost - the annual contribution to the total CERN budget for different Member States is often compared to the local price of a cappuccino per person. In addition to Member States, CERN has five Associate Member States and three Associate Member States in the pre-stage to Membership (as of January 2018).

Find out more on p34.

"CERN NATURALLY CREATES NEW OPPORTUNITIES FOR INNOVATION THAT BENEFIT SOCIETY."

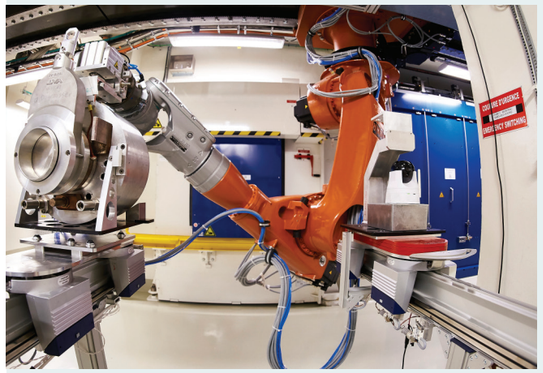
GIOVANNI ANELLI, HEAD OF THE CERN KNOWLEDGE TRANSFER GROUP.



Through novel developments in the field of accelerator technologies and detectors, and more recently in computing and digital sciences, CERN technologies and know-how have contributed to applications in many fields, including the World Wide Web, invented at CERN by Tim Berners-Lee in 1989. Behind these three pillars of technology lies a great number of areas of expertise: from sensors to robotics, and from microelectronics to superconductivity. The volume of data and the complexity of data analysis are the drivers behind CERN's expertise in digital sciences. This includes: large computing infrastructure projects, data storage, fast networks, simulation software, artificial intelligence and data analytics. The many examples of applications of CERN's technology and know-how – from medical & biomedical technologies to aerospace applications, and from industry 4.0 to cultural heritage – constitute concrete evidence that high-energy physics is a fertile ground for innovation.

MEDICAL AND BIOMEDICAL TECHNOLOGIES

The technologies and scientific advances behind high-energy physics – through developments in accelerators, detectors and computing – have historically contributed to the field of medical and biomedical technologies. CERN's unique know-how and technologies have contributed to many of these advances, with a highlight of our 2017 activities showcased here. These are related to therapy (p10), diagnostics and imaging (p12), and big data and medical computing (p13).



CERN'S MEDICAL APPLICATIONS STRATEGY

CERN's strategy for medical applications was presented to the CERN Council and approved in June 2017. Its aims are to ensure that medical applications related knowledge transfer activities are carried out without affecting CERN's core mission of fundamental research, are relevant to the medical community and to Member and Associate Member States, and are delivered within a sustainable funding model. The strategy establishes that, at least once a year, there will be a Knowledge Transfer Forum dedicated to medical applications.

CERN-MEDICIS: RADIOISOTOPES FOR MEDICAL RESEARCH

CERN-MEDICIS (Medical Isotopes Collected from ISOLDE) is a unique facility designed to produce unconventional radioisotopes with the right properties to enhance the precision of both patient imaging and treatment. It will expand the range of radioisotopes available for medical research – some of which can be produced only at CERN – and send them to hospitals and research centres in Switzerland and across Europe for further study.

Initiated in 2010 by CERN with contributions from the CERN Knowledge Transfer Fund, private foundations and partner institutes, and also benefitting from a European Commission Marie Skłodowska-Curie training grant titled MEDICIS-Promed, MEDICIS is driven by CERN's Isotope Mass Separator Online (ISOLDE) facility, which has been running for 50 years. CERN-MEDICIS entered the commissioning phase in September and produced its first isotopes on 12 December.

Project leader: Thierry Stora (Engineering Department – EN)

FROM ISOLDE TO NUCLEAR MAGNETIC RESONANCE

BetaDropNMR is a project funded by the European Research Council (ERC) that studies metal-ion interactions with biomolecules using ultrasensitive Nuclear Magnetic Resonance with radioactive nuclei from ISOLDE. In 2017, the first beta-NMR spectra of short-lived Sodium isotopes were recorded. A sister gamma-MRI project will soon use laser-polarised radionuclei for sensitive MRI studies.

Project leader: Magdalena Kowalska (Experimental Physics Department – EP)

CNAO – THE NATIONAL CENTER FOR ONCOLOGICAL HADRONTHERAPY

During 2017, CNAO (Pavia, Italy) treated 46% more patients than the previous year, for a total of 1600 patients since the first treatment. Clinical results are remarkable, showing 70% to 80% local control of tumours, across all pathologies. A crucial milestone was reached in March, when hadron therapy was included in the list of treatments provided by the national health service. CNAO also cooperates with CERN in the framework of the MEDICIS-Promed European Training Network, coordinated by CERN.

Find out more at fondazionecnao.it

MEDAUSTRON

MedAustron completed its first year as an operating cancer treatment facility after having started patient treatments in December 2016. The centre is currently operating with protons and two horizontal fixed beam lines to deliver the particle beam into the treatment rooms. At the same time, much effort is being put into commissioning further beam lines and carbon ions. The continuing cooperation between CERN and MedAustron allows the experts in Austria to fall back on the unique expertise from CERN for their tasks.

Find out more at medaustron.at

ELECTRON GUNS FOR HADRON THERAPY

MEDeGUN is an electron gun to be used in an Electron Beam Ion Source designed to serve as C6+ source for LINAC-based hadron therapy facilities. The latter require short pulses of particles at a high repetition rate, which exceeds the possibilities of present-day ion sources. In spring 2017, the MEDeGUN assembly was installed at the TwinEBIS test bench at CERN and an electron beam of more than 1A at 10 keV electron energy through the two Tesla solenoid has since been propagated with very low losses which is a major step forward.

Project leader: Fredrik Wenander (Beams Department - BE)

GANTRIES FOR HADRON THERAPY

Hadron therapy uses beams of protons or other ions to treat cancer. Massive structures called gantries allow the aiming of the beams at the patient from several angles, so that the radiation dose accumulates in the intended target, and is negligible in the surrounding healthy tissues. The size, weight and complexity of hadron therapy gantries are relevant factors in the high cost of hadron therapy facilities. CERN is currently studying a novel gantry design, based on alternative field configuration of High Temperature Superconducting coils. Preliminary studies indicate that this solution would significantly reduce the overall dimensions and weight of a hadron therapy gantry.

Project leader: Luca Bottura (Technology Department – TE)

CERN-ICEC-STFC-HOSTED WORKSHOP ON INNOVATIVE, ROBUST AND AFFORDABLE MEDICAL LINEAR ACCELERATORS FOR CHALLENGING ENVIRONMENTS

Following on from the inaugural workshop in 2016, international experts in the fields of accelerator design, medical physics and oncology met at CERN in October with the goal of designing a robust linear accelerator for use in more challenging environments. These include lower resourced areas with limited infrastructure, personnel shortage or harsh climates. The ambitious plan is to design an affordable, easy-to-use, robust medical accelerator and aims to have facilities and trained staff available to treat patients in low- and middle-income countries by 2027.

Contacts: Charlotte Jamieson (STFC), Norman Coleman (ICEC), Manjit Dosanjh (Accelerators and Technology Sector – ATS)

“KNOWLEDGE TRANSFER FOR THE BENEFIT OF MEDICAL APPLICATIONS HAS BECOME AN ESTABLISHED PART OF CERN’S PROGRAMME.”

FREDERICK BORDRY, CERN’S DIRECTOR FOR ACCELERATORS AND TECHNOLOGY & CHAIR OF THE CERN MEDICAL APPLICATIONS STEERING COMMITTEE.

A CHIP FOR THE MEDICAL IMAGING INDUSTRY

In 2017, the FastIC project, funded by the CERN Knowledge Transfer Fund, kicked off. The project aims at developing a successor to CERN’s well known eight-channel, ultra-fast NINO chip.

Over the past decade, several R&D licences for NINO were granted in a wide variety of fields. Recently there has been an increase of interest in using NINO for time-of-flight positron emission tomography (TOF-PET). In 2016 and 2017, the Molecular Imaging Instrumentation Lab from Stanford Medicine and the Sherebrooke University in Canada integrated NINO in their TOF-PET R&D projects. This development is now also catching the attention of the Medical Imaging industry.

FastIC project leader: Rafael Ballabriga (Experimental Physics Department – EP)

A VERSATILE GAS DETECTOR

GEM (Gas Electron Multiplier) is a gas detector extensively used in high-energy physics with applications in medical imaging, biotechnology, material analysis, radiation therapy dosimetry, radiation detection monitoring and even astrophysics.

This CERN patented technology has more than 50 R&D and commercial licensees around the world. In 2017, CERN experts have been developing two GEM variants: i) The Optical readout GEM, which is being tailored for online dose imaging in hadron therapy and ii) the GEMpix detector, which has applications in conventional radiotherapy.

Project leaders:

GEMPix: Marco Silari (Occupational Health & Safety and Environmental Protection Unit – HSE)
Optical Readout GEM: Leszek Ropelewski (Experimental Physics Department– EP)

CERN EXPERTISE FOR X-RAYS

G-ray Switzerland, a company developing innovative particle detection systems, has signed an R&D collaboration agreement with CERN.

The collaboration will explore the performance of low temperature bonding processes using CERN know-how and expertise in microelectronics, microfabrication, detector development and characterisation techniques. This collaboration will help improve patient X-ray radiography.

Find out more at g-ray.ch

MEDTECH CONFERENCES

Workshop on Medical Applications of Spectroscopic X-ray Detectors

Spectroscopic X-ray imaging is a key application field for Medipix. CERN has been organising this series of workshops since 2011, with the fourth one taking place in May. Of 132 invited participants, roughly half were from industry. All of the major medical equipment suppliers active in the spectroscopic Computed Tomography field were represented, as well as the most prestigious medical schools.

Michael Campbell, (Experimental Physics Department –EP) Chair of the Workshop Scientific Committee

SCINT: inorganic scintillators and their applications

Since 1992, the CERN Crystal Clear Collaboration has been organising the SCINT conference series. In September, for its 25-year anniversary, SCINT gathered more than 270 participants from academia and industry who discussed the latest achievements in scintillators and their applications, including in the medical field. An industrial exhibition hosted the stands of 19 companies.

Etiennette Auffray (Experimental Physics Department – EP), SCINT 2017 Conference Chair

BIG DATA TOOLS FOR THE GENOME

The GeneROOT project aims to use ROOT, a data processing framework developed at CERN for the high-energy physics community, to analyse large genomics datasets. The project is run by CERN openlab in collaboration with King’s College London. As well as creating a ‘minimal viable platform’ in 2017, discussions were held throughout the year with the medical community; Maastricht University Hospital, Maastricht University, King’s College London, and SIDRA Medical Centre in Doha, Qatar, will provide initial test use cases for the platform.

Project leader: Fons Rademakers (Information Technology Department – IT)

CLOUD COMPUTING FOR STUDYING DEVELOPMENT OF THE BRAIN

The BioDynaMo project aims to design and build a cloud-based computing platform for rapid simulation of biological tissue dynamics, such as brain development. The project is part of CERN openlab’s collaboration with Intel on code modernisation, and is carried out together with Newcastle University, Innopolis University and Kazan Federal University. During 2017, work continued to improve the code base, so as to fully harness the capabilities of modern hardware; backup-and-restore functionality was improved; the foundations were laid for running on the cloud and ParaView (a popular scientific visualisation engine) was integrated, meaning that life scientists can visualise and interact with their simulation even as it is running.

Project leader: Alberto Di Meglio (Information Technology Department – IT)

HOW CAN MACHINE LEARNING IMPROVE VACCINE PRODUCTION?

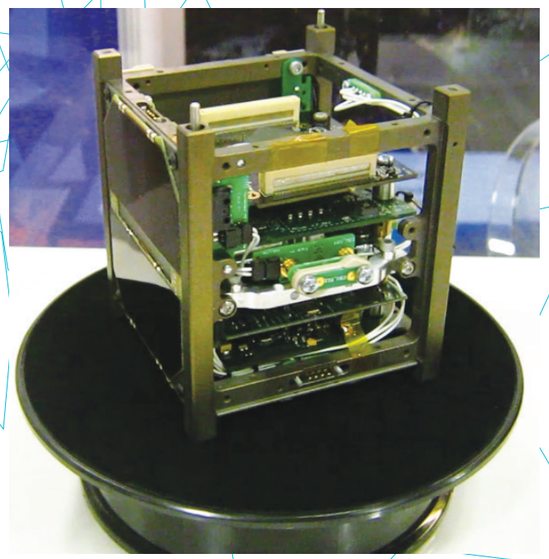
A team of experts from CERN shared their expertise on machine learning with Sanofi Pasteur, the vaccines business unit of Sanofi, a global life sciences company. This was achieved by means of a four-day training course tailored to address topics specifically of interest to Sanofi-Pasteur, with the aim of improving vaccine production and consequently helping even more people to access vital vaccines.

The course was built around ROOT, the data analysis framework used to analyse HEP data, and the Toolkit for Multivariate Data Analysis (TMVA), a library of associated machine learning algorithms. The main objective of the course was to apply novel machine learning techniques to various vaccine production challenges that had proven hard to solve using conventional methods. New opportunities came to light and several of the teams involved will test and explore machine learning tools further.

Project leaders: Sergei Gleyzer & Lorenzo Moneta (Experimental Physics Department –EP)

AEROSPACE APPLICATIONS

Aerospace is a major application area of CERN's technologies and expertise. The overall strategy has not changed with respect to previous years, having proved to be effective. The definition and establishment of partnerships with key institutions (e.g., CNES, ASI and ESA) has allowed the targeting of different sub-domains ranging from CubeSats to larger missions for science and exploration. CERN irradiation facilities have hosted several test campaigns for users from the aerospace community. CERN aerospace applications were showcased during the RADECS-17 conference. CELESTA (CERN-Montpellier University nanosatellite mission) was selected by ESA in the frame of "Fly Your Satellite" programme.



SUPPORTED EVENTS

RADECS-17

RADECS (RADiation Effects on Components and Systems) was held in Geneva in October 2017, with a record 670 participants from 25 countries. RADECS provides an annual European forum on the effects of radiation on electronic and photonic materials, devices, circuits, sensors and systems. This year's theme was "From space to ground and below", referring to the need for radiation-tolerant systems in space, aeronautical and terrestrial applications and in underground particle physics experiments. CERN KT helped organise the Industrial Exhibition and the "Swiss Space Night" welcome reception, which included a talk from astronaut Claude Nicollier. CERN KT also contributed to CERN's stand, where the CELESTA nanosatellite Engineering Qualification Model was showcased for the first time.

ESA-CERN-SSC WORKSHOP ON SPACE RADIATION

In May 2017, the workshop "Radiation Environment and its Effects in EEE Components and Hardness Assurance for Space Applications" was organised by the Swiss Space Center at CERN. It included lectures from ESA experts.

SWISSMEM/SSIG VISIT

In May 2017, a delegation from the Swissmem aerospace specialist group (SSIG - the Swiss Space Industry Group) visited CERN to discuss collaboration opportunities. Swissmem is the leading association in Switzerland's mechanical and electrical engineering industries.

NEW MISSION FLYING CERN TECHNOLOGY: LAUNCH OF VZLUSAT-1

VZLUSAT-1 is a technological nanosatellite for in-orbit demonstration of new technologies and products, jointly developed by several Czech partners including Czech Technical University (CTU). It is well known for its "Lobster Eye" optical system, developed by a Czech company. The detection system is based on pixel sensor Timepix, developed by the Medipix collaboration. VZLUSAT-1 was launched 23 June 2017, and is part of the QB50 international network of CubeSats for multi-point, in-situ measurements in the lower thermosphere and re-entry research.

"THE CERN-CNES AGREEMENT WILL CONSOLIDATE THE SYNERGIES BETWEEN OUR TWO ORGANISATIONS."

JEAN-YVES LE GALL, CNES PRESIDENT AND ESA COUNCIL CHAIR.

CERN-CNES PARTNERSHIP

In April 2017, the French space agency CNES (Centre National d'Etudes Spatiales) and CERN signed an important framework cooperation agreement. Three projects formalised by the agreement have already begun, in part with the support of the CERN Knowledge Transfer Fund. They include radiation tests of the Eyesat nanosatellite in the CHARM facility, the use of a Radmon based secondary payload on NIMPH, and the development of fibre optic radiation and temperature sensors.

IRRADIATION TESTING IN CERN'S FACILITIES

In 2017, the following irradiation test campaigns were executed in CERN facilities by the Radiation to Electronics (R2E) project. These were carried out in collaboration with ESA, CNES and their industrial partners.

- Two state-of-the art commercial components (an SRAM and an FPGA), were tested with a 120 MeV electron beam in CERN's VESPER facility. These are candidates for the ESA JUICE mission for Jupiter exploration and showed outstanding stability.
- A high penetration test campaign using 30-40 A GeV/c heavy ion beams for several components was successfully performed for ESA in the SPS North Area facility (H8 beam line). It presented multiple benefits, e.g., avoiding de-capsulation, testing different boards and components in parallel.
- The NINANO board is a candidate for the on-board computer of the CNES EyeSat nanosatellite. A mixed-field irradiation test, required to implement radiation mitigation techniques, was performed on it in the CHARM facility.

Project leader: Ruben Garcia Alia (Engineering Department – EN)

CERN-ASI PROJECT HDMS - HTS MAGNET DEMONSTRATOR FOR SPACE

CERN and the Italian Space Agency (ASI) signed the first implementation of their bilateral collaboration framework. The project, supported by the CERN Knowledge Transfer Fund, aims to define a compact high-field magnet based on advanced high temperature superconductivity technology suitable for space applications (such as high resolution astroparticle spectrometry), and to design, build and test a demonstrator. The concept was presented during the EUCAS Conference in October.

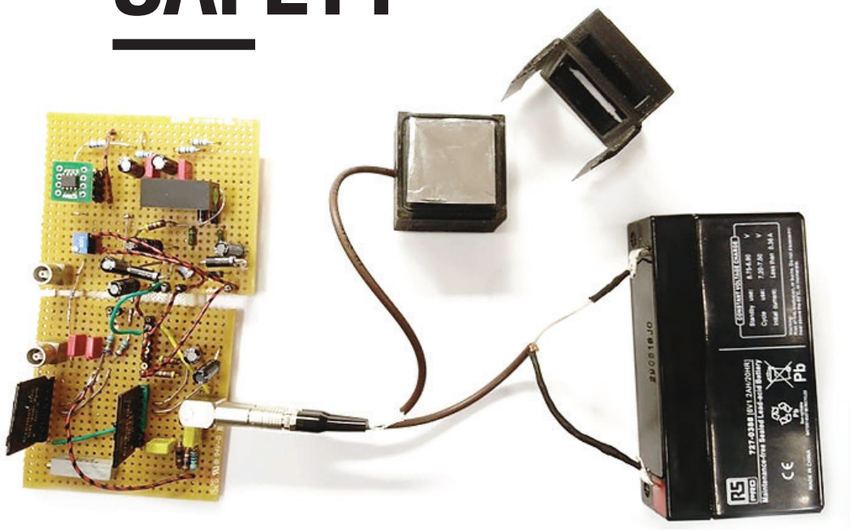
Project leader: Lucio Rossi (Accelerators and Technology Sector – ATS)

DC/DC CONVERTERS

CERN has developed a radiation-tolerant 10W Synchronous Step-Down Buck DC/DC converter chip. MAGICS Instruments, a Belgium company specialised in the design of radiation hardened integrated circuits has received a licence to incorporate this chip into digital rad-hard sensor networks (IoT) for nuclear and space environments.

Project leader: Federico Faccio (Experimental Physics Department – EP)

SAFETY



CERN's unique environment combining various types of radiation, extremely low temperatures, ultra-high magnetic fields and very high voltages, requires innovative solutions for detecting threats and preventing risks from materialising. These solutions are finding concrete applications in areas outside high-energy physics, whether through start-ups working for public safety (Neasens) or licences related to cryogenic safety (Kryolize). CERN is also keen to highlight new opportunities for industry in radiation safety (Actiwiz).

NEASENS: A START-UP TO TACKLE RADON GAS RISK

Radon is a radioactive, colourless and odourless gas produced in the decay processes of natural isotopes. It is hazardous and poses a risk when left to accumulate in buildings. Radon is one of the leading causes of lung cancer deaths, second only to smoking.

Thanks to financing from the AIDA-2020 Proof-of-Concept and the CERN Medical Applications funds, the Radon Dose Monitor (RaDoM) team will work, in conjunction with Politecnico di Milano, to develop a network of smart sensors, based on CERN technology, to monitor radon and better tackle the risks of high radon levels.

In 2017, the RaDoM project was in the final round of the MassChallenge 2017 Start-up Accelerator Programme in Switzerland, with the goal of setting up a CERN spin-off company named Neasens.

Project leader: Marco Silari (Occupational Health & Safety and Environmental Protection Unit – HSE)
Find out more at neasens.com

KRYOLIZE CRYOGENIC SOFTWARE LICENSED TO INDUSTRY

Kryolize is a software tool for sizing relief valves that protects against overpressure. In 2017, Kryolize issued its first commercial licence to one of the world's top manufacturers of cryogenic systems: Linde Kryotechnik.

The upgrade to a more professional version caught the attention of several academic and industrial partners. Kryolize benefits from funding from the CERN Knowledge Transfer Fund (see p28).

Project leader: Andre Henriques (Occupational Health & Safety and Environmental Protection Unit – HSE)
Find out more at kt.cern/kryolize-project

ACTIWIZ: MANAGEMENT OF ACTIVATED MATERIALS

In nuclear industrial installations and environments, activation of materials is a concern. Clearing activated materials in order to recycle them instead of treating all material as nuclear waste is important, but can be expensive and time-consuming.

Actiwiz3 is a powerful simulation software, developed at CERN, that can be tailored to specific radiation fields, which can save time and significantly reduce the cost of management of activated materials.
This new opportunity is available under a commercial licence.

Project leaders: Chris Theis & Helmut Vincke (Occupational Health & Safety and Environmental Protection Unit – HSE)

INDUSTRY 4.0

Industry 4.0 is a massive trend of increasing automation and efficiency in manufacturing processes with connected sensors and machines, autonomous robots and big data technology. CERN's accelerators, detectors and computing facilities call for the use of the latest industry 4.0 technology, while the technological solutions to CERN's own challenges can be used in the automation industry.

METROLOGY KNOW-HOW BEING DEPLOYED ON ELECTRICITÉ DE FRANCE'S NETWORK

CERN's Large Metrology section has developed highly specialised expertise in metrology, in particular concerning commercially available Hydraulic Levelling System sensors and Wire Positioning Systems. A consultancy agreement was recently signed with Electricité de France, where CERN will provide up to 10 days of consultancy in 2017, five days in 2018 and another five days in 2019.

Project leader: Helene Durand (Engineering Department – EN)

POWER ELECTRONICS: POWERING THE MAGNETS OF ESRF

CERN power converters are high-end designs with very stringent specifications. Enabled by support from the CERN Knowledge Transfer Fund, a software layer for controls compatibility was built in 2017, making it possible for the technology to be transferred outside the lab. The European Synchotron Radiation Facility (ESRF) recognised the advantages of the technology and will be acquiring two Megadiscap Power Converters to power the magnets of their upgraded facility.

Project leaders: Jean Paul Burnet, Davide Aguglia & Jean-Marc Cravero (Technology Department – TE)

LG DISPLAY GETS LICENCE ON MIDDLEWARE SOFTWARE FOR FACTORY AUTOMATION

LG Display, the leading global display manufacturer, has factories around the world producing a variety of innovative displays for all kinds of hardware. In 2017, a licence agreement was signed between LG Display and CERN, giving them access to controls middleware software from CERN to be used in factory automation across their plants. The software, which was originally developed for the LHC to provide a common software communication infrastructure for the accelerator controls, will now be adapted to its new application. In September 2017, training of four Korean engineers was completed, contributing further to the knowledge transfer project.

Project leader: Wojtek Sliwinski (Beams Department – BE)

QUASAR FRAMEWORK: CONTRACT WITH WIENER POWER ELECTRONICS SIGNED

The quasar framework is a collaborative, open source effort, for rapid, model-driven development of Open Platform Communications Unified Architecture (OPC-UA) servers, with applications in industrial controls. In 2017, a collaboration agreement with the third industrial power supply vendor, Wiener Power Electronics, was signed - moving the existing installed base of Wiener hardware towards a more integrated modern controls framework, while the company provides support for the latest industry standards, such as OPC-UA.

Project leaders: Ben Farnham (Beams Department – BE) & Piotr Nikiel (Experimental Physics Department – EP)

CULTURAL HERITAGE

Cultural heritage takes many forms: from the tangible legacy of monuments, artwork and books, to digital resources, either newly created or used to ensure cultural preservation. The concept also includes intangible (such as language and oral traditions) and natural elements (such as flora and fauna). This heritage may seem remotely connected to CERN's technological advances, yet the opposite is true: in 2018, several projects related to art restoration and digital preservation are using CERN technology.

2018 IS THE EUROPEAN YEAR OF CULTURAL HERITAGE.
#EUROPEFORCULTURE

A 19th century impressionist painting, seen with the naked eye (top) and with InsightART's X-ray system (bottom), which reveals a woman's bust that was partially removed and painted over.

X-RAY EYES FOR ART AUTHENTICATION AND RESTORATION

The Medipix technology developed by the Medipix2 and Medipix3 collaborations represents a new tool within the portfolio of non-destructive inspection methods used by art conservators, restorers, galleries, auction houses and other experts in the field of art studies. The modern cutting-edge X-ray imaging detectors enable X-ray spectral imaging (XRSI), material resolved X-ray imaging and soon X-ray "colour" imaging (XRCI) useful for the inspection of paintings. The high-resolution spectral information acquired by these devices helps assess the condition of paintings and identify painted-over or forged pieces. The technology has been commercialised by InsightART, a start-up company based in Prague.

Project leader: Michael Campbell (Experimental Physics Department – EP)

DIGITAL PRESERVATION FOR LIBRARIES

Each year CERN's Knowledge Transfer group organises the NTNU Screening Week: students from the Norwegian University of Science and Technology (NTNU) visit to identify the commercial potential of CERN technologies. The CERN spin-off TIND is a success story of the 2012 edition. TIND provides solutions for library management and data preservation based on CERN's open source software Invenio, which was created in 2002 to run its internal document server. TIND has now expanded its operations in the USA; its client portfolio includes the United Nations, the UNESCO International Bureau of Education, the International Telecommunications Union, the Max-Planck Institute for Extraterrestrial Physics and numerous universities.

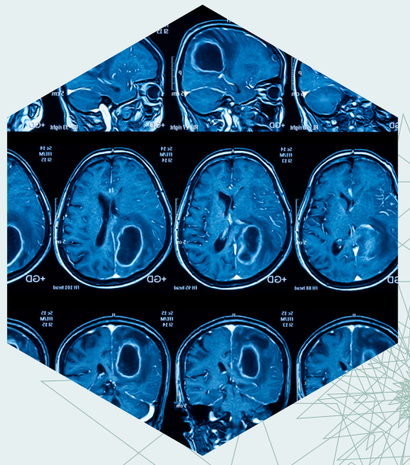
Find out more at tind.io

BRINGING PORTABLE ACCELERATORS IN MUSEUMS

A portable Radio Frequency Quadrupole (RFQ) accelerator is expected to open up new possibilities for the analysis of fine art and cultural artefacts. It will employ a technique called Particle Induced X-ray Emission (PIXE) to measure the elements present within a sample exposed to a beam of low-energy particles. This will enable on-site studies of artworks – including, for example, which pigments were used, and if the piece is genuine. The project, named MACHINA (Movable Accelerator for Cultural Heritage In-situ Non-desctructive Analysis), is a collaboration between the Italian Istituto Nazionale di Fisica Nucleare (INFN) and CERN, through INFN's cultural heritage network CHNet. The Opificio Delle Pietre Dure, one of the world's leading institutes in the field of art restoration, will be the first user.

Project leader: Serge Mathot (Engineering Department - EN)

EMERGING TECHNOLOGIES



Scientists and engineers at CERN are also working on technologies that are still in the "emerging" phase, and are expected to have significant impact in the future. Close industry collaboration is often vital for both the development of the technology and to maximise the potential impact these technologies can have on society.

SUPERCONDUCTIVITY: FROM NEURO-IMAGING TO ENERGY SUSTAINABILITY

At low temperatures, certain materials become superconducting. Superconducting wires can conduct orders of magnitude more current than a traditional wire, and are at the heart of the LHC's powerful superconducting magnets. Applications have long since found their way into society, for example with Magnetic Resonance Imaging.

Future physics experiments require increasingly higher magnetic fields, and so CERN finds itself at the forefront of driving innovation in superconductivity. Apart from in-house research, CERN is an important player in large projects such as FuSuMaTech (see p36) and EASITrain (EU-funded collaboration).

Close industry collaboration is also vital, e.g., for production of novel materials in the field of High-Temperature Superconductivity (HTS). Cheaper and more practical systems may bring disruptive developments in energy transportation and storage, wind turbines, magnetic levitation, and much more. A hackathon on superconductivity held at CERN in 2017 displayed many creative ideas.

Technical contacts: Lucio Rossi (Accelerators and Technology Sector - ATS), Luca Bottura, Amalia Ballerina & Glyn Kirby (Technology Department - TE)

DATA COMPRESSION HARDWARE

Orthopix is a method for compressing sparse data arranged in a matrix. It is designed for high-energy physics experiments, focussing on readings with high spatial and time resolution, but such architecture can be used in any application where it is essential to reduce the total amount of data to be extracted from the detector. In 2017, new leads for future applications in diverse fields such as Proton Therapy and Subsea market were followed with the help of a group of students from the Norwegian University of Science and Technology.

Technical contacts: Walter Snoeys (Experimental Physics Department – EP) & Piero Giubilato (Padova University).

3D CHARACTERISATION OF SEMICONDUCTOR DEVICES

Financed by the CERN Knowledge Transfer Fund, this project aims to develop a method and platform to extract doping and electric field profiles within semiconductor devices by non-destructive femtosecond laser induced Two-Photon Absorption. Several fields could benefit from this development, amongst them Quality Control & Assurance of semiconductor devices, E-Field and Charge Collection Efficiency mapping of photosensors, and radiation damage studies for high-energy physics detectors.

Project leader: Michael Moll (Experimental Physics Department – EP)

HUMAN EXCELLENCE AND EDUCATION

2416
Active Alumni members as of December 2017

>2 Million
Mentions of CERN or the LHC on social media

952
High-school teachers in CERN's 2017 Teacher programmes

CERN's scientists, engineers and technicians are at the cutting edge of theoretical and experimental research, engineering and computing. There are also experts in many other fields, such as finance, law and procurement. Some of this 'human capital' remains at CERN long-term, while some leaves and joins CERN's rich alumni community.

Education is fundamental to CERN's mission; be it for researchers taking advantage of CERN's unique learning environment, school teachers striving to inspire their pupils or members of the general public visiting CERN's permanent and travelling exhibitions.

"JOIN THE HIGH-ENERGY NETWORK TO KEEP TAKING PART IN CERN'S COLLABORATIVE ENDEAVOUR."

LAURE ESTEVENY, HEAD OF CERN ALUMNI PROGRAMME.

HUMAN CAPITAL AND TRAINING

At CERN, learning happens in many ways; formal courses or more informal on–the-job training. The majority of courses on offer, as one would imagine, are in the technical domain but there are also Personal Development & Communication, language and leadership courses specialising in more 'soft' skills. These courses are available to all CERN personnel throughout their career and some even to CERN alumni.

There are many opportunities for students in a wide range of disciplines, as well as for more senior scientists, engineers and technicians to come to CERN for a limited period. For the first time, there are more than 800 fellows (including 122 funded by the European Commission as part of the 27 currently running Marie Skłodowska-Curie actions projects) and 200 administrative, doctoral and technical students at CERN. They gain experience, expertise and valuable transferable skills, which can be used as they further their careers. This is a perfect example of knowledge transfer between CERN and its Member States.

In addition, nearly 250 university students from all over the world take part in the annual summer programmes (Summer Student Programme and CERN openlab Summer Student Programme). While at CERN, students visit CERN facilities, attend lectures and events such as the CERN Summer Student Webfest. These programmes are highly over-subscribed and have become renowned for their high quality.

2500 CERN Staff members of which 1180 scientific staff
More than 800 Fellows from 24 countries working at CERN
CERN's alumni network (alumni.cern) was launched in June 2017

OUTREACH AND THE GENERAL PUBLIC

CERN is always keen to engage with the general public, raising interest, sharing knowledge and hopefully inspiring young people to pursue a career in STEM (Science, Technology, Engineering, and Mathematics).

CERN was the proud guest of honour at the annual Automnales Fair in Geneva, Switzerland in November. Around 145 000 people attended, and most stopped at the CERN stand. The stand, which covered 1000m^2, brought all aspects of fundamental research and its applications to life using exhibits, activities, films, quizzes and even virtual reality headsets. CERN volunteers imparted their knowledge and enthusiasm for the laboratory's work to an audience diverse in both age and background.

CERN also reached many more thousands of visitors via its presence at other exhibitions throughout the year. The flagship 'Accelerating Science' exhibition was on show for four months in Turkey (an Associate Member State).

With more than two million mentions of CERN or LHC on social media in 2017, CERN continues to have a strong presence on social media channels and is currently active on Twitter (the two million followers mark was reached in March), Facebook, Instagram, YouTube and LinkedIn.

Over 135 000 visitors (a 12% increase compared to 2016) had a guided tour of CERN.
More than 50 000 visitors came to the permanent exhibitions: Universe of Particles and Microcosm.
CERN's website home.cern saw more than five million visits in 2017, 60% of which were new visitors.

EDUCATION WITH TEACHERS AND SCHOOLS

CERN runs or is involved in many programmes to motivate young people in their study of physics, be it directly or via their teachers.

The Beamline for Schools competition invites high-school student teams to come to CERN to perform experiments they have designed, using a CERN accelerator beam. It is now in its fourth year. The winning teams in 2017 were from Canada and Italy.

Several new projects within IRIS (Institute of Research in Schools) use the CERN@school kit based on the Timepix chip (developed at CERN by the Medipix2 collaboration). The projects allow schools to use real scientific equipment and data (including data from the International Space Station).

In May, the High-School Students Internship (HSSI) Programme was launched for students aged 16-19. The five pilot countries for the programme are Bulgaria, France, Hungary, Norway and Portugal. So far, 116 young people have been offered an intense two-week internship at CERN.

CERN's many Teacher Programmes continued to provide high-school teachers with cutting edge educational resources.

952 teachers from 58 different countries participated in 31 National and two International Teacher Programmes.
7230 visitors used the S'Cool LAB facilities (S'Cool LAB Days and Cloud Chamber workshops).

A LONG-TERM RELATIONSHIP WITH KNOWLEDGE TRANSFER - MEET ALESSANDRA LOMBARDI

"WORKING WITH THE KNOWLEDGE TRANSFER GROUP HAS BEEN AN INTERESTING AND ENRICHING DISCOVERY, AND I AM LOOKING FORWARD TO CONTINUING IT." ALESSANDRA LOMBARDI, SENIOR ACCELERATOR PHYSICIST AT CERN.

Alessandra Lombardi, Senior Accelerator Physicist at CERN (Beams Department - BE), is working on a daily basis with hadron sources and Linacs for CERN's Accelerator Complex. While this is her main focus, Lombardi has also been an important contributor to CERN's projects in the field of accelerators for medical purposes.

Alessandra Lombardi was part of the team who designed a new High-Frequency Radio Frequency Quadruple (RFQ), to be used in hospitals for treating cancer. With assistance from the Knowledge Transfer group, a patent was filed for the RFQ and then the technology was licensed to the CERN spin-off company ADAM (Applications of Detectors and Accelerators to Medicine), which is now part of Advanced Oncotherapy. Lombardi has continuously supported ADAM with testing and commissioning. A modified version of the RFQ design, PIXE-RFQ, is currently developed in collaboration with INFN for use in arts analysis.

Alessandra and Maurizio Vretenar (Accelerators & Technology Sector – ATS) are also coordinating a newly launched study for future ion therapy facilities. This initiative follows in the wake of the Proton Ion Medical Machine Study (PIMMS), carried out at CERN between 1996 and 2000. PIMMS was the basis for the construction of two ion-therapy centres - CNAO in Italy, followed by MedAustron in Austria (see p11). By always striving to find matching funds for the projects she is involved in, Alessandra has received several rounds of funding from the CERN Knowledge Transfer Fund and from the CERN Medical Applications budget line. In addition, she is an active member of the Medical Applications Project Forum (MAPF), meeting once a month with other CERN medical applications experts to discuss the status of on-going activities, to explore new avenues, and to develop synergies.

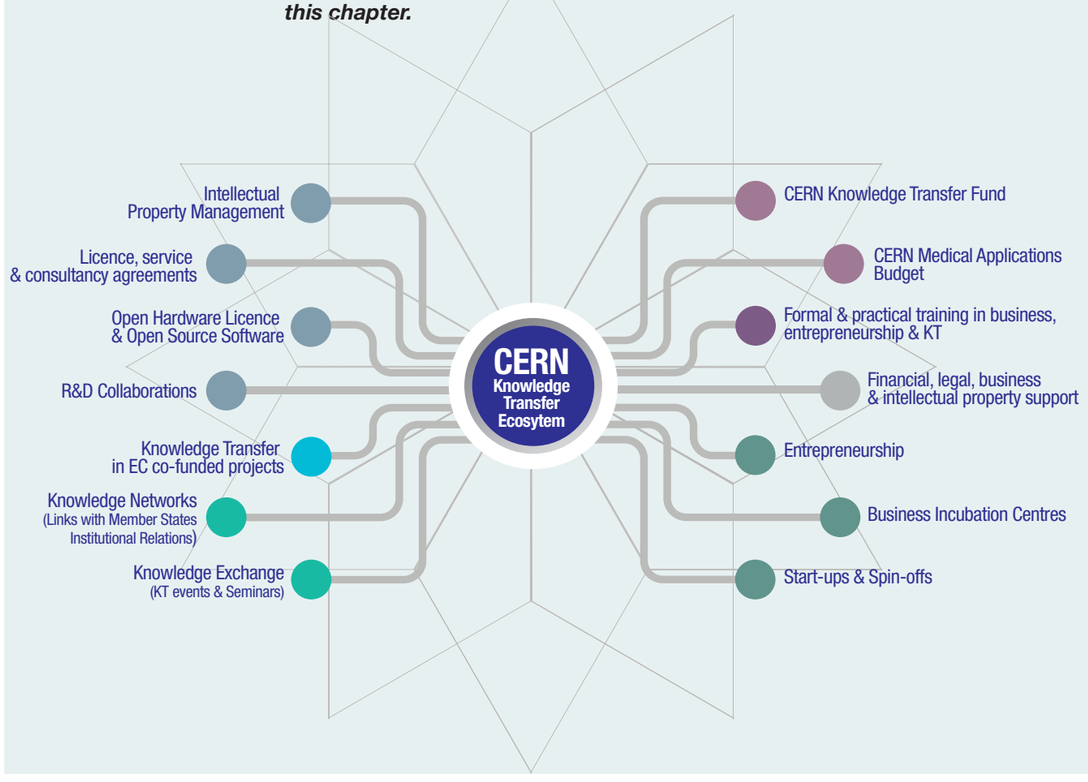
Alessandra has interacted with the CERN Knowledge Transfer group through many of its activities, whether through funding opportunities or intellectual property support. Her expertise and contributions have also amplified the reach of the group's activities, and helped promote the transfer of CERN's know-how and technology beyond high-energy physics. Lombardi remarks that working with the Knowledge Transfer group over the years has been an interesting and enriching discovery – "I am looking forward to continuing the collaboration," she says.

ACCELERATING INNOVATION

KNOWLEDGE TRANSFER TOOLS

CERN is an international hub for scientists, engineers and professionals, committed to advancing their fields of expertise. The knowledge created by CERN's community has the potential to create impact by leading to innovation in fields beyond high-energy physics. This innovation can happen organically, but actively investing in the process can boost its impact and reach. CERN invests in many activities to make this happen.

The CERN Knowledge Transfer group provides advice, support, training, networks and infrastructure to ease the transfer of CERN's know-how to industry and eventually society. These activities are part of CERN's knowledge transfer ecosystem, illustrated below and described in more detail throughout this chapter.



INTELLECTUAL PROPERTY AND LICENSING

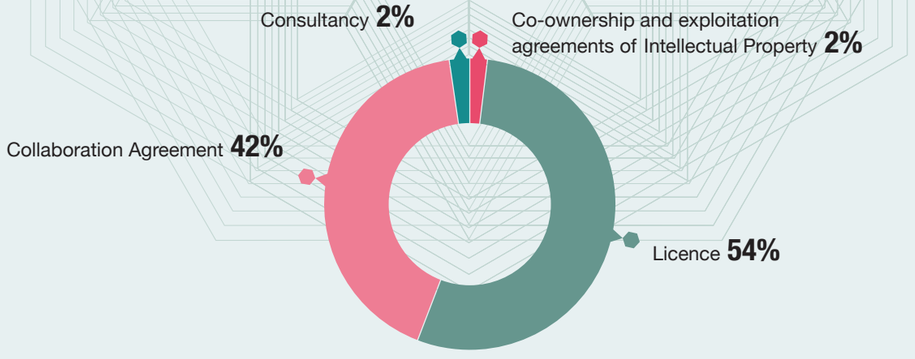
73
New technologies disclosed internally in 2017

41
Knowledge Transfer contracts signed in 2017

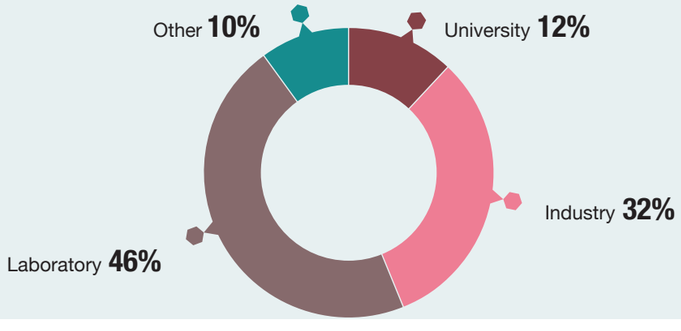
Intellectual property (IP) lies at the core of successful knowledge transfer at CERN. It enables CERN to claim being at the origin of a novel technology, making it possible to share its knowledge to reach society.

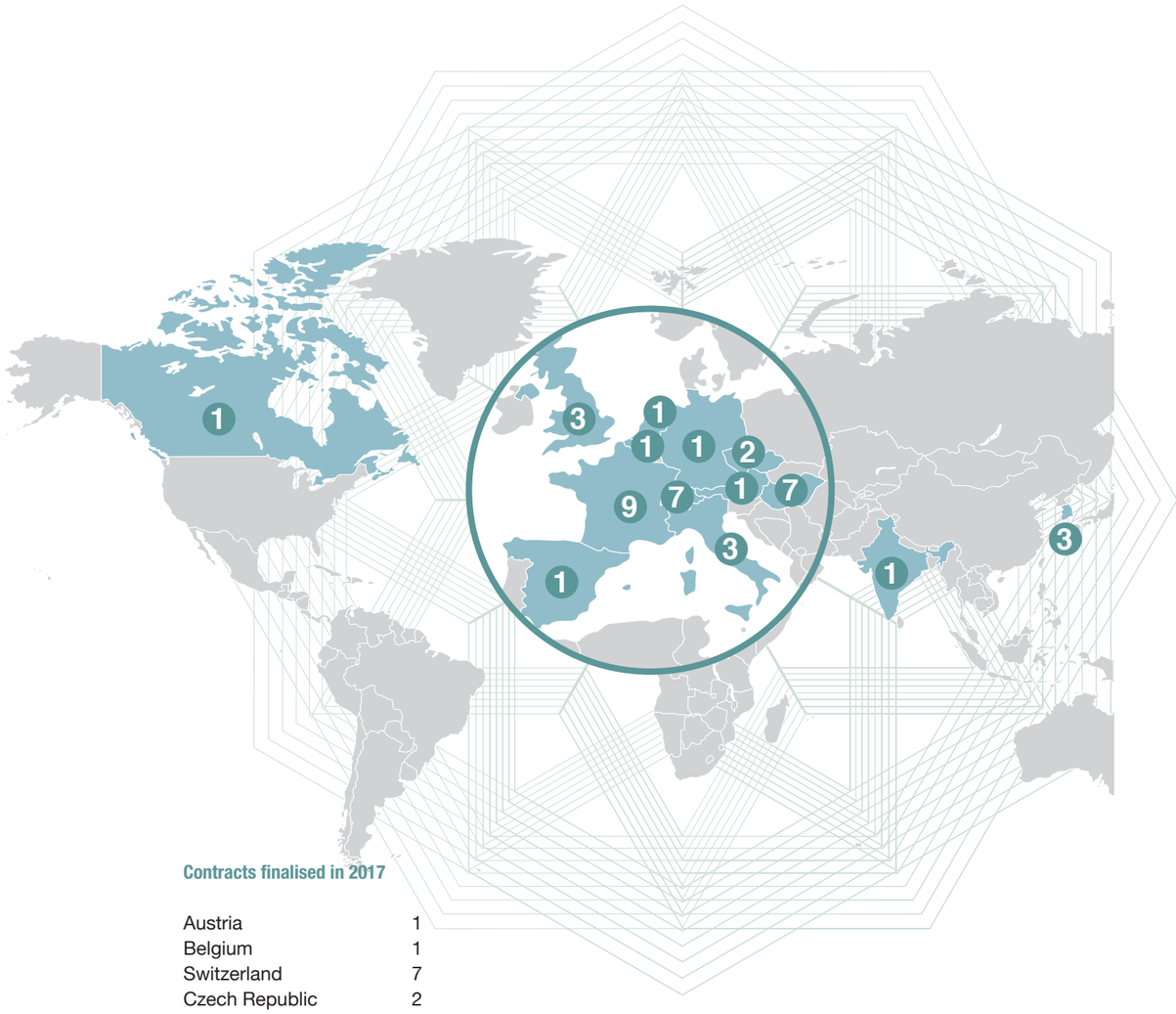
In 2017, CERN's scientists and engineers brought 73 new technologies to the attention of CERN's Knowledge Transfer group. This included a variety of software, electronics, detector and accelerator component designs at various degrees of technology readiness. CERN's policy is to disseminate its technologies as widely as possible to industrial and institutional partners within its Member States, however patenting represents only a tiny part of CERN's approach to IP. CERN will only consider patenting where it might help mitigate the financial risks of investing further in the development of a technology. CERN's patent portfolio is a reflection of this, and currently comprises 34 patent families, a number significantly lower than organisations of a similar size. In addition to its technology portfolio, CERN also has a wealth of scientific and technical competence, across a large variety of expertise, which is accessible through collaboration and consultancy agreements.

TYPE OF CONTRACT



PROPORTION OF CONTRACTS BY PARTNER





Contracts finalised in 2017

Austria	1
Belgium	1
Switzerland	7
Czech Republic	2
Germany	1
Spain	1
France	9
Hungary	7
Canada	1
UK	3
India	1
Italy	3
Netherlands	1
Republic of Korea	3

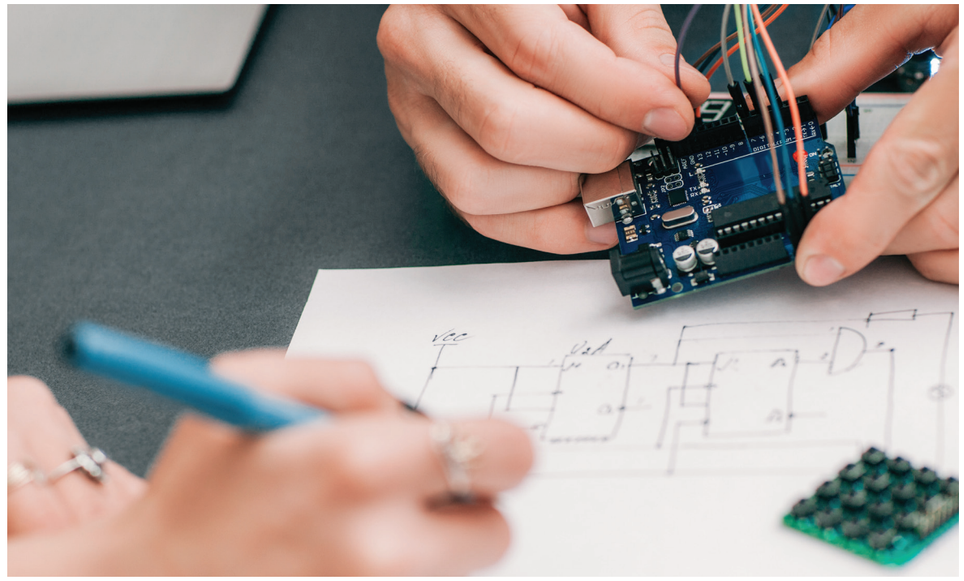
TRAINING

CERN invests time in training its personnel to be aware of the support systems in place to transfer their know-how to society. In 2017, the "Introduction to Knowledge Transfer Tools" course helped participants understand the services and support available to the CERN community from the KT group and following on from its successful launch in 2016, the "Finding Happiness in Patent Information Databases" course, explained how the wealth of technical information disclosed in patents worldwide can benefit colleagues involved in research and development. Both courses, organised and delivered by the KT group, can be found in the CERN training catalogue.

OPEN SOURCE SOFTWARE AND HARDWARE

The principle of openness is stated in CERN's founding Convention, and the Organization has continuously been a pioneer in this field: all LHC publications have been published under Open Access conditions, and Open Source licences are also used to release software and hardware.

The cornerstone of the "Open Source" philosophy is that recipients should have access to all its building blocks, such as source code for software, schematics for electronics and mechanical designs, in order to study it, modify it, and redistribute it to others.



OPEN SOURCE SOFTWARE

Several CERN software technologies are developed with open collaboration in mind. To name a few: Zenodo, a free Open Data repository for use beyond the high-energy physics community; the CERN Open Data Portal, the access point to a growing range of data produced through the research performed at CERN; the TMVA libraries, providing machine learning functionality to the ROOT data analysis framework; and the Quasar framework, allowing to streamline the controls of electronic devices. Another example is Invenio, an open source library management software package. In 2017, after getting support from the CERN Knowledge Transfer Fund, the work of making Invenio Open Archivial Information System (OAIS) compliant for long term preservation of digital content started - taking on other market segments with the combination of digital preservation and fast and easy search.

CERN is also contributing to many open source projects, small or large, that promote collaboration within the community in the larger sense, not only the scientific world. These are sometimes initiated by CERN, or CERN is involved in projects led by external institutes or partners. For example, CERN contributes significantly to the OpenStack project, and over 90% of CERN's computing resources are currently provided through a private cloud based on OpenStack. The CERN storage system EOS, an example of a CERN-initiated open source project, was created for the extreme LHC computing storage requirements. GEANT4 is an example of an open source software collaboration with many institutes from outside CERN. It is a widely used transport code, which simulates how particles propagate through matter.

OPEN SOURCE HARDWARE

The CERN Open Hardware Licence, drafted and published by the CERN Knowledge Transfer group, was born out of the wish to openly disseminate CERN's hardware designs. The licence fosters the dissemination of schematics and hardware documentation, and of improvements made to the hardware. The licence itself can be used by anyone on their own hardware documentation, and is a good example of how addressing CERN's needs can have surprising benefits for society as it encourages the availability of open hardware worldwide.

Hardware components continue to be licensed under Open Hardware conditions by CERN, in order to ease access and use by other entities. An example is the 'Probe/switch card systems' that was introduced in 2017, originally developed by CERN in order to test the High Granularity Calorimeter (HGC) of CMS.

Another example of CERN's work with Open Hardware is CERN's BE CO-HT contribution to the development of KiCad. KiCad is an Open Source Software Tool for designing printed circuit boards (PCB). 2017 saw many improvements, including a better connectivity algorithm, via stitching, easier management of component libraries and import from Eagle, a proprietary PCB design tool.

41
Projects funded since 2011

15-220 kCHF
Range of funding received per project

8
CERN departments and units funded since 2011

CERN KNOWLEDGE TRANSFER FUND

The CERN Knowledge Transfer (KT) Fund is a tool to bridge the gap between research and industry, so that society can benefit. Through a competitive process, it selects innovative projects based on a CERN technology, with potential for positive impact on society.

Established in 2011, the fund is supported in part through revenues from commercial agreements concluded by CERN's Knowledge Transfer group. Current CERN employees can apply – the grant can fund material or students and fellows related to the knowledge transfer project. Since 2011, 41 projects have been funded, with each project receiving 15-220 kCHF. Projects usually last from 1 to 4 years.

THE CERN KNOWLEDGE TRANSFER FUND BRIDGES THE GAP BETWEEN RESEARCH AND INDUSTRY, SO THAT SOCIETY CAN BENEFIT.

PROJECTS FUNDED IN 2017

A compact superconducting magnet for space applications - see p15

Project Name:
"High field HTS magnet demonstrator for space."

Project leaders:
Gijs de Rijk (Technology Department – TE), Luca Bottura (Technology Department – TE) & Lucio Rossi (Accelerators & Technology Sector – ATS)

Value of award: 104.5 kCHF

Project duration: 4 years

A new compact accelerator for cultural heritage - see p18

Project Name:
"Design & construction of a transportable RFQ for PIXE analysis."

Project leaders:
Alexej Grudiev (Beams Department – BE), Alessandra Lombardi (Beams Department – BE), Serge Mathot (Engineering Department – EN), Eric Montesinos (Beams Department – BE) & Maurizio Vretenar (Accelerators & Technology Sector – ATS)

Value of award: 104.5 kCHF

Project duration: 3 years

A non-destructive laser application for quality control & radiation studies in semiconductor devices - see p19

Project Name:
"Development of a 3D laser characterisation method of semiconductor devices Two Photon Absorption Transient Current Techniques."

Project leaders:
Michael Moll (Experimental Physics Department – EP)

Value of award: 120 kCHF

Project duration: 2 years

Note: this project was selected in 2016, and funded in 2017

CERN KNOWLEDGE TRANSFER (KT) FUND – OVERVIEW

Who can apply? Current CERN employees can apply.
Who is on the selection committee? The selection committee is composed of CERN's department heads or their representatives, as well as members of the CERN Knowledge Transfer group.
What can the grant fund? The grants can fund material or students and fellows related to the knowledge transfer project.
What conditions should my proposed project meet? In order to be considered for funding, projects should meet the following conditions:

- The project proposal must be approved by the department head.
- The salary cost of staff members involved in the project are covered by the department.
- The project is based on a CERN technology.
- The Intellectual Property (IP) required to execute the project is owned or co-owned by CERN and there is no conflict over the IP required to execute the project.

Find out more at kt.cern/funding/kt-fund

CERN MEDICAL APPLICATIONS (MA) BUDGET – OVERVIEW

Does your project have medical applications? Consider the CERN Medical Applications Budget.

25
Projects funded since 2014

64 kCHF
Average funding received per project

7
CERN departments and units funded since 2014

What is the CERN MA Budget? CERN provides a limited amount of seed funding for projects with medical applications. Since 2014, 25 projects have been funded with an average grant of about 64 kCHF per project. The MA budget has funded the equivalent of 21 researchers since 2014.
Who can apply? Current CERN employees can apply, if their project is related to medical applications.
Who is on the selection committee? Proposals are first presented to the Medical Applications Project Forum (MAPF), and then to the CERN Medical Applications Steering Committee (CMASC). The CMASC evaluates whether the project fits into CERN's strategy for medical applications activities, and decides whether to fund them or not.
Should I apply to the CERN MA budget or the CERN KT fund? If your project is related to medical applications, you must first apply to the CERN Medical Applications budget. If your project is considered relevant to CERN's strategy, but there is no available funding within the CERN Medical Applications budget, you can apply for the CERN Knowledge Transfer Fund.

Find out more at kt.cern/funding/medtech

KT PARTNERS @ CERN

In close collaboration with the CERN Knowledge Transfer group, IdeaSquare and openlab explore how research and industry can collaborate in the innovation process. These partners have different roles in the CERN innovation ecosystem.

OPENLAB

What
A collaboration between CERN and leading technology companies that works to accelerate the development of cutting-edge Information and Communication Technologies (ICT) solutions for the worldwide LHC community and wider scientific research.

Why
The Large Hadron Collider (LHC) is the most complex machine ever built; it produces enormous amounts of very complex data. CERN openlab was established in 2001 to help ensure that members of its scientific community have access to the very latest ICT solutions, thus helping them to gain scientific insights from this data and further push the frontiers of physics.

How
- Collaborating with leading ICT companies to assess the merits of new technologies and carry out joint development. Working to understand the evolving ICT requirements of the LHC, as published in a white paper in September.
- Training the next generation of ICT specialists through the CERN openlab Summer Student Programme and other educational activities.
- Participating in joint R&D activities and sharing knowledge with other research communities.

IDEASQUARE

What
Located in a technical hall (B3179) next to the Globe of Science and Innovation, IdeaSquare is a place to bring people together to generate new ideas and work on conceptual prototypes related to detection and imaging in an open environment.

Why
Contributing to future CERN programmes such as High-Luminosity LHC, ILC and FCC, among others, includes developing next-generation leading detector, imaging and related computing technologies. This requires a shared technical platform which, in parallel, has a strong connection to society, and inspires next-generation scientists, engineers and entrepreneurs by exposing them to the frontier R&D environment at CERN.

How
- Developing and testing ideas by taking advantage of the space offered, including the machine workshop there, electrical workshop, 3D printers, light lab, and VR headset for rapid prototyping.
- While not in peak use, IdeaSquare can also host special innovation-related events.

EVENTS

73
Events organised or attended in 2017 by the CERN KT group

21
Countries where KT-related events were held

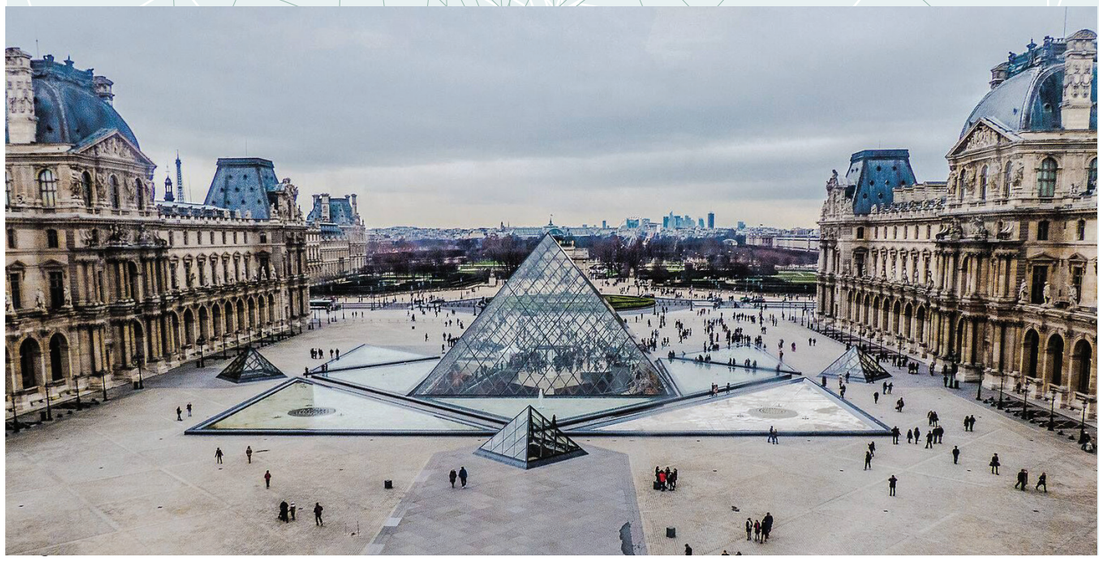
950
People attended the CERN Knowledge Transfer Seminars in person or via webcast in 2017

Knowledge transfer at CERN could not happen without the knowledge exchange between experts in science, technology and industry. Meeting in person is an important step to create and accelerate this exchange. The CERN Knowledge Transfer group organises and presents at key events to make this happen. Some of these events take place at CERN, like the Knowledge Transfer Seminars, which are also webcast, or the CERN Entrepreneurship Meet-Ups (EM-Us – see p40). Others take place worldwide with a focus on our Member States.

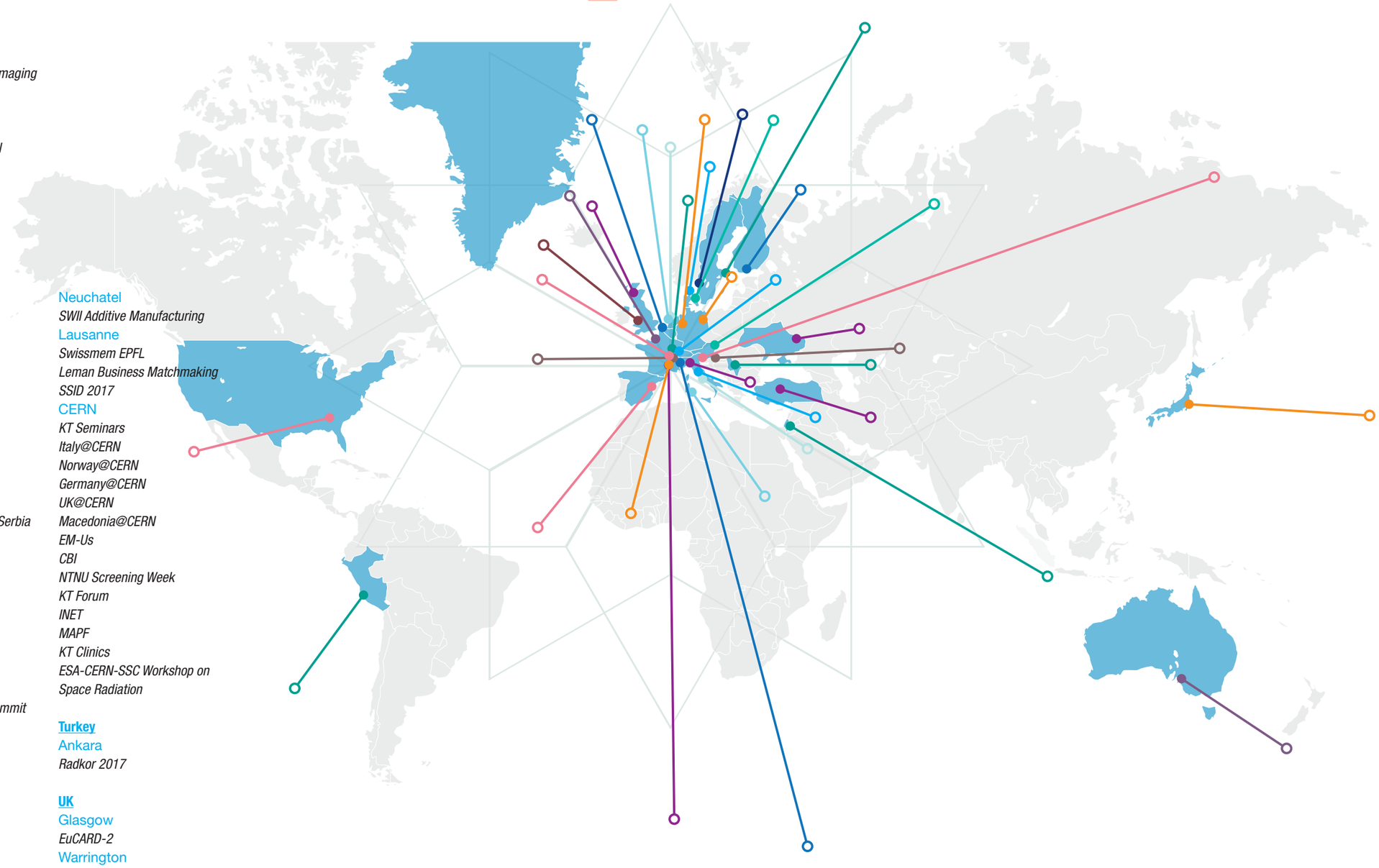
KNOWLEDGE TRANSFER SEMINARS

The CERN Knowledge Transfer seminar series, which was launched last year, continued in 2017 with six more seminars. Diverse topics captivated audiences watching both live in the auditorium or remotely via webcast.

The year started with a seminar about the accelerator under the Louvre and its upgrade (the new AGLAE) making the unlikely link between accelerators and art. Two of the seminars focused on entrepreneurship and gave an insight into setting up a business after working at CERN while another described the work of a biomedical company created to commercialise spectral imaging technology. The Early Career Reseachers working in medical applications at CERN, were again given the opportunity to present their projects in order to showcase the diversity of medical applications that arise from technologies developed at CERN. In November, the Director-General of the World Intellectual Property Organisation (WIPO) visited CERN to discuss Intellectual Property and Innovation.



WHERE YOU MET THE CERN KNOWLEDGE TRANSFER GROUP IN 2017



Australia
Adelaide
IAC2017

Austria
Vienna
ESTRO 36
Pioneers 2017
EANM
Austrian BIC Symposium

Belgium
Brussels
IPR, Technology Transfer & Open Science
LEAPS
Charleroi
CERN Meets Wallonia

Denmark
Copenhagen
IPAC17
CREMLIN Innovation Workshop
Aarhus
ENLIGHT

Finland
Helsinki
CERN Roadshow
Slush

France
Archamps
IBD4Health
Gex
School Presentation
Paris
AIDA 2020 Academia Meets Industry
Chamonix
SCINT 2017
Grenoble
Imaging & Sensors Summit

Germany
Berlin
International Symposium on Release of Radioactive Material from Regulatory Control
Dusseldorf
MEDICA 2017

Israel
Tel Aviv
Round table on Evolving Practices, New models and Players
Israel Spirit of Innovation and Cooperation

Italy
Orosei
MEDAMI 2017
Milan
MEEW
Varenna
International Workshop on Imaging
Rome
Entrepeneurship Day
Pistoia
International Day of Medical Physics

Japan
Yokohama
PTCOG56

Netherlands
Amsterdam
MT25 Conference
Eindhoven
Entrepeneurship Day

Peru
Lima
Hello Tomorrow Peru

Serbia
Belgrade
Meeting of the Chamber of Commerce and Industry of Serbia

Slovenia
Ljubljana
Industry & Science Day

Spain
Barcelona
FSFE Software Licensing Conference
R&D Process Excellence Summit

Sweden
Stockholm
AESIS Conference
Gothenburg
TTO Circle Event

Switzerland
Geneva
G3ID
EUCAS 2017
RADECS
Automnales
EYH 2017
UNITEC
CERN-UNIGE Workshop
Neuchatel
SWII Additive Manufacturing
Lausanne
Swissmem EPFL
Leman Business Matchmaking
SSID 2017
CERN
KT Seminars
Italy@CERN
Norway@CERN
Germany@CERN
UK@CERN
Macedonia@CERN
EM-Us
CBI
NTNU Screening Week
KT Forum
INET
MAPF
KT Clinics
ESA-CERN-SSC Workshop on Space Radiation

Turkey
Ankara
Radkor 2017

UK
Glasgow
EuCARD-2
Warrington
Hi-Lumi Industry Day

Ukraine
Kharkov
Medical Physics School

USA
Atlanta
IEEE

COLLABORATIONS

Knowledge Transfer is a contact sport which, to be done successfully, starts with an exchange between researchers, businesses, and policy makers. By strengthening links with its Member States (p34) and investing in knowledge transfer networks (p35), avenues are created for collaborations between the CERN community, policy makers and industry in those countries. To enhance this further, CERN also participates in European Commission co-funded projects, several of which have a strong knowledge transfer component (p36), and engages with International Organisations (p38).

22
Member States

5
Associate Member States as of January 2018 (Lithuania became an AMS on 8 January 2018)

3
Associate Member States in the pre-stage to membership

STRENGTHENING LINKS WITH MEMBER STATES

Thanks to the Knowledge Transfer (KT) Forum, CERN Business Incubation Centres, National Industry Days at CERN, and participation in events organised in the countries themselves, CERN actively engages with its Member States and Associate Members States.

The KT Forum aims to develop relationships with industry in Member States by nurturing discussions between CERN's KT group and KT delegates from the Member States. On 30 November, the first thematic forum on medical applications took place, bringing together experts from physics and medical communities. The forum focused on how CERN's technologies can contribute to the three fields of therapy; diagnostics and imaging; and big data and medical computing.

Industry Days at CERN allow suppliers from Members States to exhibit and connect with procurement and knowledge transfer experts, and learn about CERN's latest technologies available to transfer. This year, 139 firms participated from four Member States.

The Knowledge Transfer group proactively participates in locally organised events in Member State countries as demonstrated on the events map (p32).

NETWORKS

HEPTECH – THE HIGH-ENERGY PHYSICS TECHNOLOGY TRANSFER NETWORK

HEPTech is the high-energy physics technology transfer network, made up of leading European institutions and universities from 16 different countries. Each of these research organisations works across a range of world-leading scientific areas to meet the technological challenges of exploring fundamental particle, astro-particle and nuclear physics. Building upon its concept of Academia-Industry Matching Events (AIMEs) as a valuable instrument for fostering exchanges between researchers and industry, in 2017, HEPTech co-organised the Technology Transfer Programme of the IEEE NSS/MIC in Atlanta, USA and the European Cryogenics Days in Germany. The Network held its fourth Symposium for early-stage researchers and organised capacity building events for its members.

Collaboration spotting – spotting collaborations in particle physics

CERN collSpotting software, a visualisation and navigation platform for large and complex datasets, continues to be instrumental to R&D in the field of large-scale visual analytics to support semantic data and knowledge fusion. This tool is also an important source of information that feeds into networks like HEPTech. In 2017, CERN, BME and WIGNER signed a collaboration agreement where CERN collSpotting software will be used for applied research in four different fields: pharmaceuticals, IT networks analytics, neurology and mapping the educational space.

Project leader: Jean-Marie Le Goff (Industry, Procurement & Knowledge Transfer Department - IPT)

ENTERPRISE EUROPE NETWORK

EEN, the Enterprise Europe Network, is a network of more than 60 countries managed by the European Commission (EC) for SMEs with international ambitions. CERN provides the network with its technologies and takes part, in selected cases, in initiatives aimed at exchanging know-how with SMEs. In 2017, the CERN Knowledge Transfer group agreed with the EC and with selected national EEN "nodes" on how to valorise CERN technologies through direct exchanges and also, tentatively, through CERN procurement actions.

TTO CIRCLE – TECHNOLOGY TRANSFER OFFICES CIRCLE

CERN has actively participated in the activities of the TTO Circle coordinated by the EC Joint Research Centre (JRC). The new TTO circle Memorandum of Understanding between the JRC and CERN was signed in March 2017. CERN presented the approach taken by the Organization to foster both Open Innovation and Open Science at the workshop "IPR, Open Science and Technology Transfer" organised by the JRC in collaboration with the European Commission's Directorate General on Research and Innovation (March 2017). CERN took part in the European TTO Circle's tenth plenary meeting in Oxford (June 2017), where a CERN representative was appointed as member of the new Board of the TTO Circle.

ENLIGHT – THE EUROPEAN NETWORK FOR LIGHT ION HADRON THERAPY

The ENLIGHT network brings together multidisciplinary experts for the advancement of particle therapy for cancer treatment. Its 15th annual meeting took place at the Aarhus University Hospital. Talks, focused on three hot topics: clinical trials, imaging for hadron therapy, and accurate delivery and measurement of dose in real time. Following the success of last year, another one-day training course was held as part of the event and the importance of the need to continue this is underlined by the fact that the "ENLIGHT education and training project" has been approved, within the CERN & Society Foundation. This opens a new chapter for ENLIGHT and its community to help young scientists flourish in the future.

Find out more at https://giving.web.cern.ch/content/enlight-training

The network also continued to share news and updates on current hadron therapy research through two publications of the Highlights magazine.

Find out more at http://enlight.web.cern.ch/media/highlights

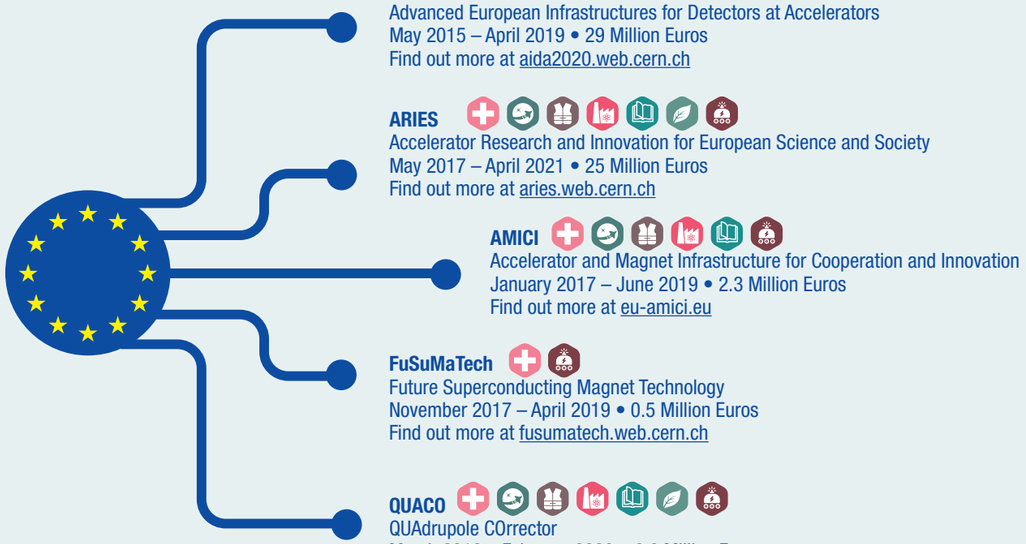
5
Current CERN EC co-funded projects with a strong KT component

3
Projects started in 2017

>63 M Euros
Total project costs

EUROPEAN COMMISSION CO-FUNDED PROJECTS

CERN participates in projects co-financed by the European Commission (EC). This strengthens existing collaborations and creates new links with European universities, research institutes, laboratories, and industrial partners. These projects often have a knowledge transfer component, through collaborative R&D&I programmes with industry, pre-commercial procurement activities, or specific work packages dedicated to innovation and Proof-of-Concept (PoC) funding. This is the case for the five projects presented below. Their project costs are over 63 million euros, partly provided by the EC, and distributed amongst the participating institutes and companies.



AIDA-2020
Advanced European Infrastructures for Detectors at Accelerators
May 2015 – April 2019 • 29 Million Euros
Find out more at aida2020.web.cern.ch

ARIES
Accelerator Research and Innovation for European Science and Society
May 2017 – April 2021 • 25 Million Euros
Find out more at aries.web.cern.ch

AMICI
Accelerator and Magnet Infrastructure for Cooperation and Innovation
January 2017 – June 2019 • 2.3 Million Euros
Find out more at eu-amici.eu

FuSuMaTech
Future Superconducting Magnet Technology
November 2017 – April 2019 • 0.5 Million Euros
Find out more at fusumatech.web.cern.ch

QUACO
QUAdrupole COrrector
March 2016 – February 2020 • 6.6 Million Euros
Find out more at quaco.web.cern.ch

Medical & Biomedical Technologies · Aerospace Applications · Safety · Industry 4.0 · Cultural Heritage · Environment · Emerging Technologies

AIDA-2020

AIDA-2020 aims to support the development of detector systems for high-energy physics projects, whilst promoting the transfer of these developments to other fields and industry, where they may lead to societal applications. In 2017, the AIDA-2020 project hosted an interdisciplinary Academia Meets Industry (AMI) event to encourage the exchange of knowledge and identify areas of common interest between medical applications (medical imaging and image processing) and high-energy physics.

In parallel, three Proof-of-Concept (PoC) projects have been selected and launched following an open call: Silicon-based Microdosimetry System for Advanced Radiation Therapies, Advanced Through Silicon Vias for Pixel Detectors, and RaDoM-Radon Monitoring. These PoCs received some seed funding from AIDA-2020 and aim at advancing and demonstrating technologies for market applications.

A second AMI event will be organised in 2018 on detectors and sources for non-destructive testing.

ARIES

ARIES is designed to improve the performance, availability, and sustainability of particle accelerators, transferring the benefits and applications of accelerator technology to both science and society, and enlarging and integrating the European accelerator community.

Already at its kick-off in 2017, the ARIES consortium leveraged its consistent industrial participation (seven out of 41 partners) to harness the market potential of accelerator related technologies. A call for proposals was launched late 2017 to fund application-focused Proof-of-Concepts to enhance the impact of accelerator technology in society.

AMICI

AMICI is supported by ten institutes who are contributing to the operation and construction of Accelerator Research Infrastructures in Europe. The aim of the project is to build the conditions for consolidating and exploiting this infrastructure across the accelerator community – in order to strengthen the capabilities of European companies to compete on the global market.

Investigations have been taking place to identify the technical competencies and facilities that may be made available to industry – including for beam instrumentation, cryogenics, magnets, radio frequency, material analysis, vacuum technology, chemistry and surface characterisation, as well as the associated human expertise. This information will form the basis of a public report to be issued during the course of the project.

FUSUMATECH

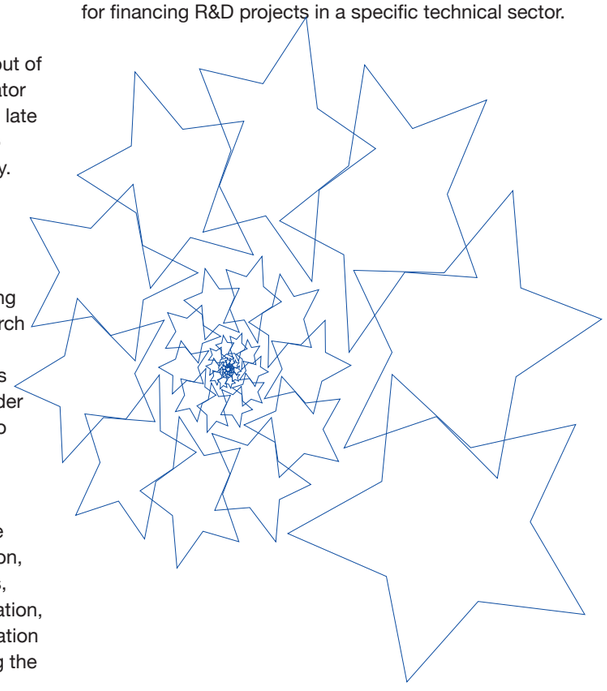
The FuSuMaTech Initiative aims at establishing a strong and sustainable R&D&I European network for structuring and strengthening the field of superconductivity and associated industrial applications. It will enlarge the innovative potential, especially in High Field Nuclear Magnetic Resonance and Magnetic Resonance Imaging, opening future breakthroughs in neuro-imaging.

The project kick-off was held in October 2017, gathering six European research institutes and six European companies active in the field of superconductive magnets. All work packages and concrete deliverables were presented and aligned amongst the participants.

QUACO

QUACO is a Pre-Commercial Procurement (PCP) project for the design, R&D and industrial prototyping of high-tech quadrupole magnets that will be used for focusing the beams for the high luminosity upgrade of the LHC. QUACO is coordinated by CERN and brings together three other research institutes (CEA, CIEMAT and NCBJ) that will contribute to the magnet development and public procurement.

Three companies were selected in 2017, in phase 2 of PCP, to provide innovations in accelerator technologies. The project has advanced towards becoming an EU showcase for financing R&D projects in a specific technical sector.

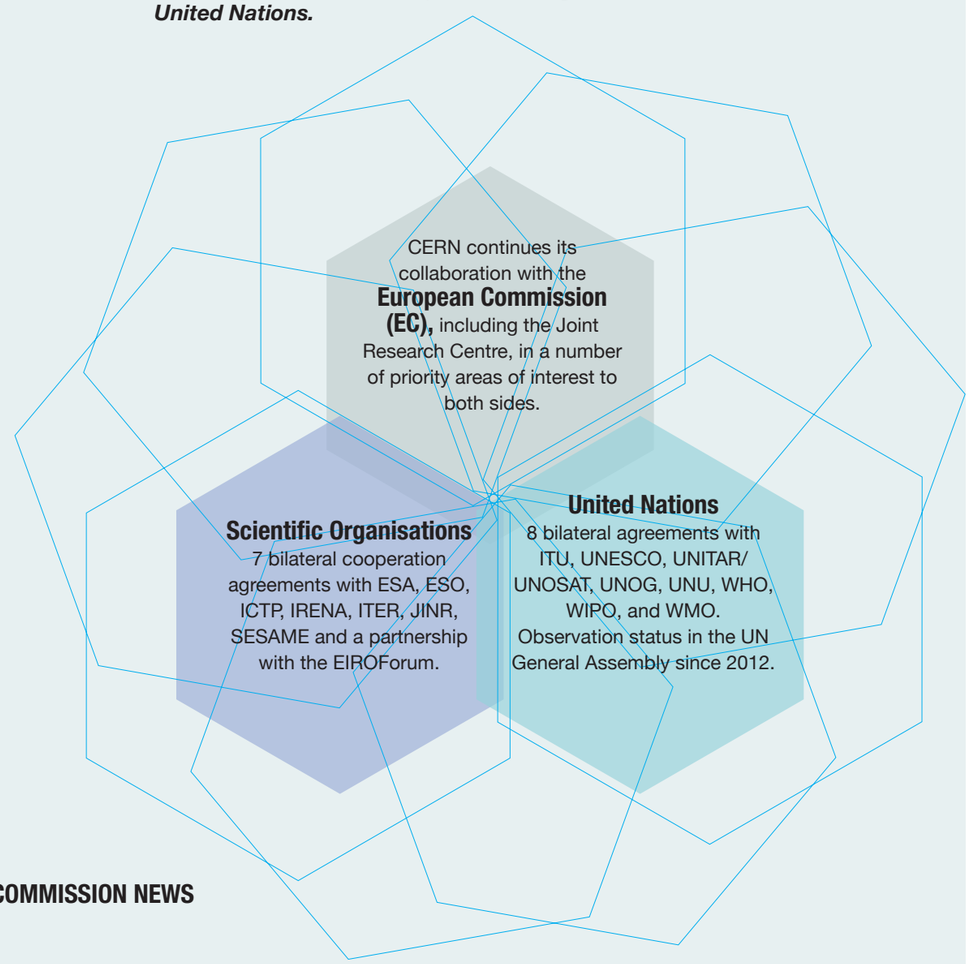


15
Bilateral cooperation agreements with scientific and international organisations

5
Sustainable development goals (SDGs) in which CERN fully contributes within its current mandate

INTERNATIONAL ORGANISATIONS

Thanks to a structured network of relations with other International Organisations (IOs), CERN consolidates the importance of science, scientific education, technology, and innovation as a driving force in the economy and society. CERN focuses on collaboration with the European Commission, scientific organisations as well as the United Nations.



EUROPEAN COMMISSION NEWS

The European Commission (EC) and CERN continued their cooperation in a number of priority areas of mutual interest, such as research and e-infrastructures, open access to data and publications, careers and mobility of researchers, gender in research and innovation, as well as technologies for ITER and medical applications. The cooperation with the **Joint Research Center** of the EC was pursued through joint activities related to knowledge transfer and intellectual property management, big data, neutron data for nuclear energy applications, and production of medical isotopes.

The CERN-EC Annual meeting took place in November 2017 in Geneva. The two sides reviewed their joint activities including the plans for the next year, and exchanged views on some major EC programmes and initiatives, notably the new EU Framework Programme for Research and Innovation, the European Innovation Council, and the European Open Science Cloud.

SCIENTIFIC ORGANISATIONS NEWS

A landmark year for SESAME (Synchotron-light for Experimental Science and Applications in the Middle East): 2017 started well for SESAME, the international laboratory hosted in Jordan, with first beams circulating in SESAME's main ring on 17 January. Constructed under the EU CESSAMag project coordinated by CERN, the main ring establishes SESAME as a world-class facility. SESAME was inaugurated by Jordan's King Abdullah II on 16 May, and saw first light on 23 November. The year ended as it began: on a high note, as early results were presented at the SESAME users' meeting in December.

ITER (International Thermonuclear Experimental Reactor) is an international nuclear fusion project. After many years collaborating with CERN on key technologies related to superconductors, current leads and materials, ITER entered in 2016 its installation phase. On request of ITER, CERN organised in January 2017 a workshop including visits to exchange on LHC installation challenges and return on experience. Today, the CERN-ITER collaboration is centred on technical and scientific consultancy activities. The main areas of collaboration are metallurgy and manufacturing. Future collaborations are planned in several other fields such as superconductivity, magnet technology, high and ultra-high vacuums, and radiation monitoring.

JINR (Joint Institute for Nuclear Research) in Dubna (Russian Federation) is an intergovernmental multidisciplinary research centre for nuclear sciences. The Committee of Plenipotentiaries of the Governments of the Institute Member States is the supreme body of the Institute and CERN holds observer status to this Committee. In April 2017, JINR representatives unveiled JINR's new seven-year strategic plan, as well as opportunities for further CERN-JINR collaboration. In September 2017, JINR and CERN co-organised the CERN-JINR European school for high-energy physics in Portugal.

Within the **EIROforum** partnership, CERN and the other European intergovernmental research organisations continued their collaboration in 2017. This covered diverse activities such as support to winners of the European Young Scientist Contest, preparation of joint position papers on the European Open Science Cloud and the next EU Framework Programme for Research and Innovation, and organising the EIROforum School on Instrumentation.

UNITED NATIONS NEWS

The CERN-**UNITAR/UNOSAT** cooperation agreement was renewed for another partnership period, enabling UNOSAT to benefit from CERN's IT infrastructure to perform cutting-edge analysis of satellite images.

CERN participated in the 2017 UN Geneva Office's Open Day, welcoming numerous visitors on a dedicated stand at the Palais des Nations. CERN welcomed ten Heads of UN Agencies for a Laboratory visit and organised a KT seminar with the **World Intellectual Property Organisation (WIPO)** Director-General as keynote speaker.

CERN advocated for the importance of fundamental research at a UN Science, Technology and Innovation meeting in New York.

CERN & THE UNITED NATIONS SUSTAINABLE DEVELOPMENT GOALS (SDGs)

The UN's 2030 Agenda for Sustainable Development contains five targets to which CERN fully contributes within its current mandate:

SDG 3: Good health and well-being
SDG 4: Quality education
SDG 9: Industry, innovation and infrastructure
SDG 16: Peace, justice and strong institutions
SDG 17: Partnerships for the goals

ENTREPRENEURSHIP

54
Entrepreneurship Meet-Ups

23
Start-ups & spin-offs using CERN technology

9
Member State Business Incubation Centres

From a distance, the world of entrepreneurship and the world of science may seem miles apart. The former focusing on business and revenue, the latter on research and publications. CERN has a foothold in each world.

One might say that entrepreneurs and scientists have two things in common: they are always looking for funding and both are extremely passionate about what they do. Entrepreneurship at CERN combines this passion with complex technologies. CERN provides its personnel with the tools needed for business creation through initiatives such as the Entrepreneurship Meet-Ups. Its network of Business Incubation Centres is there to support entrepreneurs who wish to take CERN technologies and utilise them outside of high-energy physics.

The world of entrepreneurship and the world of science may seem miles apart. At CERN, they grow closer every day.

"WE ARE PROUD TO BE A COMMERCIALISATION PARTNER OF CERN FOR MEDIPIX TECHNOLOGY."

HANS BROUWER, CEO OF ASI.

ASI OBTAINS TIMEPIX3 LICENCE FROM CERN

Amsterdam Scientific Instruments (ASI), a spin-off from Nikhef, the Dutch Institute of Particle Physics, offers hybrid pixelated detectors for a broad range of applications both for scientific and industrial users. In 2017, ASI acquired its third licence from CERN – this time for the Timepix3 technology, a core component for ASI's next generation hybrid pixel cameras. With the newly obtained licence, the company can now deliver the systems commercially, with applications varying from X-ray imaging, electron microscopy to particle track reconstruction. Hans Brouwer, CEO of ASI, highlights that the licence demonstrates a next step in the ongoing and fruitful collaboration between ASI and CERN – "we are proud to be a commercialisation partner of CERN for Medipix technology".

BUILDING A CULTURE OF ENTREPRENEURSHIP

50TH ENTREPRENEURSHIP MEET-UP

The Entrepreneurship Meet-Ups (EM-Us) are where innovators and aspiring entrepreneurs meet at CERN. Invited experts share their knowledge and also have the opportunity for discussion and networking. In October, the 50th EM-U was celebrated with food, drinks and a special cake for the occasion, marking over two and a half years of meet-ups. 70 guests attended the event - a mix of previous speakers, entrepreneurs, academics, innovators and people interested in entrepreneurship, both from the CERN community and from outside CERN.

Find out more at kt.cern/meet-up

MARS SPECTRAL IMAGING: FROM HEP TO A BIOMEDICAL BUSINESS

In May, Anthony Butler, Chief Medical Officer in Mars Bioimaging ltd., gave a Knowledge Transfer Seminar about his entrepreneurial and scientific journey. Developed closely with CERN and the Medipix collaborations, the company's spectral scanners provide colour X-Ray images, enabling researchers and clinicians to measure biochemical and physiological processes in specimens, and in animals with diseases.

Find out more at marsbioimaging.com/mars

GLOBAL ENTREPRENEURSHIP WEEK

For the third year in a row, CERN's Knowledge Transfer Group participated in the Global Entrepreneurship Week Geneva by opening up the Entrepreneurship Meet-Ups to people from outside CERN. A panel debate on bridging the gap between science and business was held, consisting of representatives from Oak V, Pollen Robotics, IdeaSquare@ CERN, Geneva Creativity Center and CERN KT.

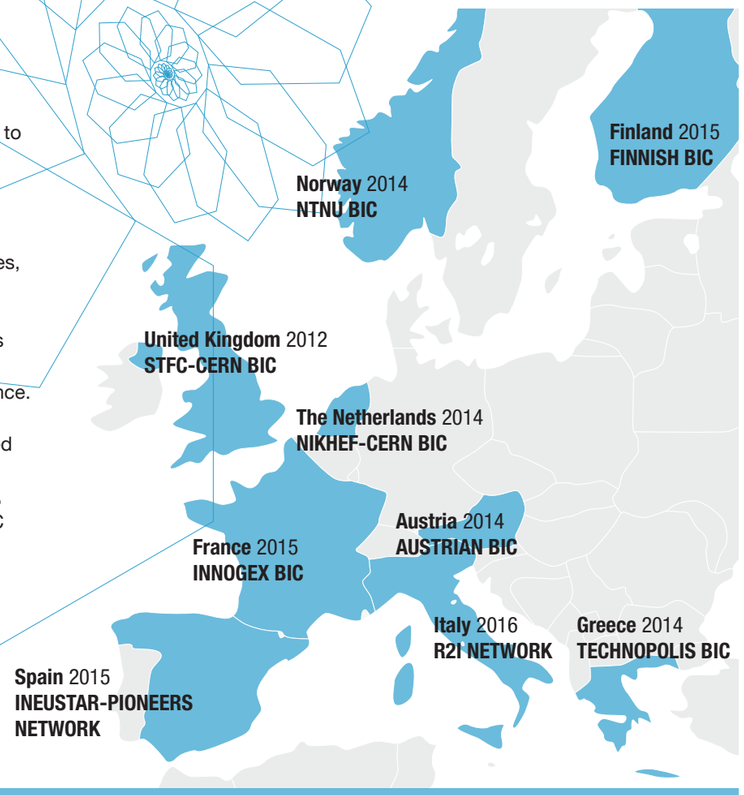
Find out more at genglobal.org/gew

BUSINESS INCUBATION CENTRES

CERN has established a network of nine Business Incubation Centres (BICs) throughout its Member States, to assist entrepreneurs and small businesses in taking CERN technologies and expertise to the market.

In practice, CERN supports the selected companies through technical visits to CERN, technical consultancy and services, and preferential rate licensing of CERN intellectual property. The BIC managers provide office-space, expertise, business support, access to local and national networks, and support in accessing finance.

In 2017, five new start-ups were accepted into a BIC. Two start-ups entered the InnoGEX BIC, while the Technopolis BIC, the STFC-CERN BIC and the Finnish BIC accepted one new start-up each.



HOW TO ENTER A BIC

Are you an entrepreneur or a start-up company? Could CERN technology solve your needs? Perhaps you qualify to enter a CERN BIC. Here is how to find out.

1) BROWSING
Most of the CERN Technology Portfolio is presented online. Browse through it, see if you find what you are looking for. No luck? Get in touch with the Knowledge Transfer group.

2) FIRST CONTACT
Get in touch with the BIC you want to join. After a first screening you will be put in touch with CERN.

3) TECHNOLOGY MATCH
Together with CERN experts you will get to know the technology better, making sure it suits your needs.

4) OFFICIAL APPLICATION
Each BIC has its own tailored application process.

Find out more at kt.cern/entrepreneurship/bic-network

ANNUAL BIC MEETING

Representatives from eight of the nine Business Incubation Centres met for the annual CERN BIC meeting in April 2017. The gathering was hosted by Nikhef in Amsterdam and was the third of its kind. The aim of these meetings is for the BIC managers to exchange best practices in fostering CERN start-ups and spin-offs.

BIC ARABA

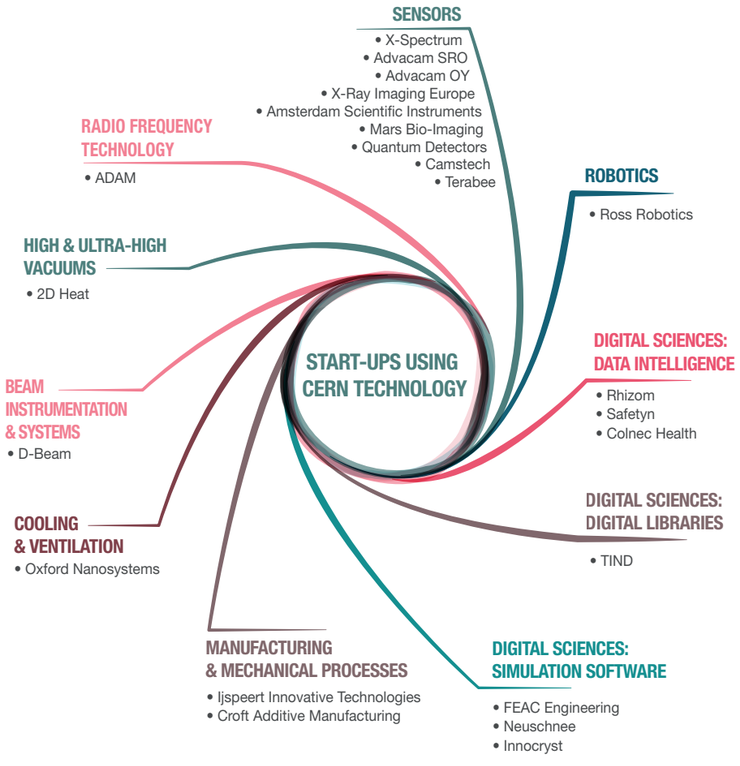
In July, the Spanish BIC network expanded to include a BIC in the Basque Country, BIC Araba. The kick-off meeting to inform those organisations interested in submitting potential cases of use of CERN technologies, and benefit from the BIC programme, took place in the premises of BIC Araba on 26 October 2017.

FIRST AUSTRIAN BIC SYMPOSIUM

The first Austrian BIC of CERN Technologies Symposium was held in December 2017 to inform Austrian start-ups, companies and other interested parties of possibilities to use CERN technologies and know-how in future product development through the CERN technology transfer programme. A personal CERN matching session was held for aspiring entrepreneurs.

START-UPS AND SPIN-OFFS USING CERN TECHNOLOGIES

CERN encourages the creation of spin-off companies and offers support to CERN personnel and external entrepreneurs seeking to establish a company based on CERN technology and/or know-how. Beyond the BIC network, the Knowledge Transfer group supports spin-offs and start-ups through a variety of different activities and mechanisms, from licensing of technologies, to business plan development and access to training programmes.



The CERN start-ups and spin-offs are either based, or partly based, on technology and/or know-how from CERN. Whatever their field of application, each start-up is related to at least one of CERN's areas of expertise. The infographic shows which of these areas of expertise the start-ups are associated with.

Find out more at kt.cern/startups

START-UPS ACCEPTED INTO A BIC IN 2017

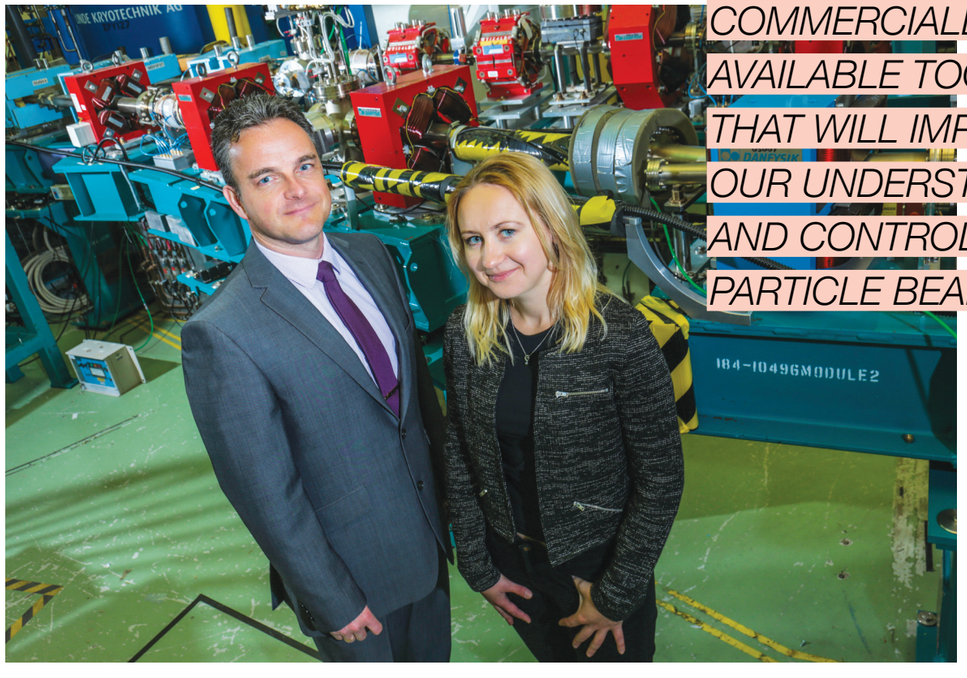
RHIZOM, InnoGEX BIC, rhizom.io
SAFETYN, InnoGEX BIC, safetyn.com
FEAC Engineering, Technopolis BIC, feacomp.com
D-Beam, STFC-CERN BIC, d-beam.co.uk
Advacam Oy, Finnish BIC, advacam.com

FEATURE: D-BEAM ACCEPTED INTO THE STFC CERN BIC

Particle beams are used in cancer treatment as well as facilities such as the Large Hadron Collider and European Spallation Source. D-Beam will offer a step-change in precision for the hundreds of large accelerators and synchrotron light sources that are currently in operation worldwide in this emerging area.

D-Beam has world leading expertise in particle beams diagnostics, developed through intense and long-lasting research collaborations with CERN. The company will also have access to specific parts of CERN intellectual property through the STFC-CERN.

"D-BEAM WILL BE ABLE TO TRANSLATE CUTTING EDGE RESEARCH INTO COMMERCIALLY AVAILABLE TOOLS THAT WILL IMPROVE OUR UNDERSTANDING AND CONTROL OF PARTICLE BEAMS."



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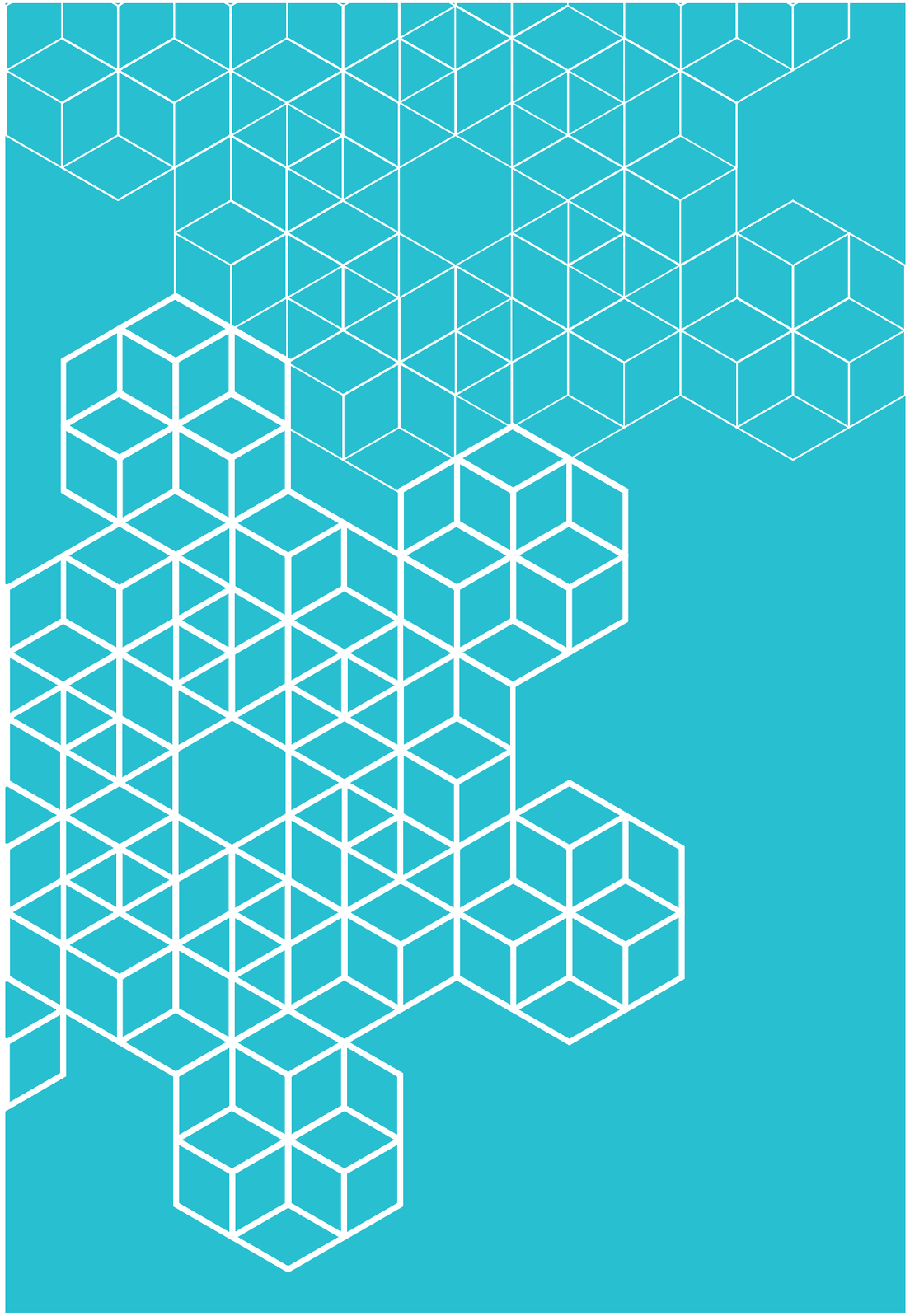


CERN